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RESEARCH ARTICLE

The Red Sea Aristotle

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Abstract

Deriving from a larger investigation into the sources used by Leonidas of Byzantium for his second-century AD *Halieutica*, this article argues that a handful of passages in Aelian's *De natura animalium* (3.18, 3.28, 10.13, 10.20, 11.21, 11.23–24, 12.24–25[24] and 12.27[25]) comprise a coherent series indebted to the same section of Leonidas' work. More importantly, all of these accounts are ultimately derived from a Peripatetic treatise on the marine fauna of the Red Sea. The author, whom I dub the Red Sea Aristotle, based his treatise on first-hand research likely conducted at a Ptolemaic settlement in the northern Red Sea. This treatise seems to have been known to at least one later Alexandrian lexicographer, while Agatharchides of Cnidus may have had access to it already in the middle of the second century BC. This Peripatetic treatise invites a reconsideration of orthodox claims about the fate of scientific zoology in the Hellenistic period.

I. Introduction

Leonidas of Byzantium, second-century AD author of an influential prose treatise on fish and fishing, has been of interest primarily to scholars exploring vexed questions related to halieutic source material in a range of texts both Greek and Latin. This article, too, is interested in *Quellenforschung*, although not with the goal of identifying additional passages in more famous authors that may rely on Leonidas, but rather in asking where that author found *his* material and then exploring the surprising implications. In composing his *Halieutica*, Leonidas seems to have sought out Hellenistic accounts left uncollected by the more popular encyclopaedias and zoological compendia. These texts included, perhaps most unexpectedly, a previously unrecognized Peripatetic zoological treatise.

After a brief introduction to Leonidas and his sources (section II), I argue in section III that a mysterious passage in Aelian's *De natura animalium* (3.18) derives, by way of Leonidas, from a reliable first-hand account of a peculiar but common Red Sea species, the masked puffer fish. In section IV, I argue that Aelian includes a handful of additional passages (3.28, 10.13, 10.20, 11.21, 11.23–24, 12.24–25[24] and 12.27[25]) that form a coherent series borrowed from the same section of Leonidas' *Halieutica*. Leonidas seems in turn to have made use of a scientific treatise on the marine fauna of the Red Sea. In section V, I argue that the author of this treatise was a careful student of Aristotle's biology and that he conducted a systematic programme of first-hand research. The evidence is sufficient to allow us to identify the project as Peripatetic. In the sixth section, I discuss the author's historical context; his research seems to have been conducted at a Ptolemaic settlement on the Red Sea no earlier than the middle of the third century BC, and I explore the possibilities of identifying him with other attested figures. In the seventh section, I discuss the likelihood that the historian Agatharchides of Cnidus consulted

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this treatise already in the second century BC, in which case a number of fragments owed to a kind of appendix to book 5 of his *On the Erythraean Sea* could shed additional light on the nature of this otherwise enigmatic treatise. Finally, I conclude by proposing possible relationships between this treatise and Ptolemaic royal ideology and by suggesting that its evidence perhaps demands a more nuanced account of the fate of scientific zoology in the Hellenistic period.

II. Leonidas of Byzantium

We know little about Leonidas of Byzantium. Max Wellmann argued in the 19th century that Leonidas was writing circa 100 BC and that his work on fishing was the source for shared material in diverse texts ranging from the pseudo-Ovidian *Halieutica* and Pliny's *Natural History* to Plutarch's *Moralia*, Aelian's *NA*, Oppian's *Halieutica* and Athenaeus' *Deipnosophistae*.[1] Rudolf Keydell effectively demolished Wellmann's arguments, showing that Leonidas postdates not only the author of the Latin *Halieutica* but also Pliny and Plutarch.[2] Unfortunately, Wilhelm Kroll had already restated Wellmann's conclusions in an entry in Pauly–Wissowa that continues to mislead less wary scholars, including the author of the notice for Leonidas in a recent encyclopaedia of ancient natural scientists.[3] Even more recent scholarship suggests confusion is likely to persist with respect to the most basic facts.[4] It would seem that the key evidence deserves to be restated.

In the second book of his *NA*, Aelian gives an elaborate account of the friendship between a boy and a dolphin at Poroselene (2.6). He attributes this account to Leonidas, who, he says, claimed to have witnessed the interaction personally.[5] Keydell is surely correct in arguing that Leonidas is a contemporary of Pausanias, who seems to offer independent testimony to what must have been a well-known tourist attraction at Poroselene.[6] Both are probably at most a generation or so earlier than Oppian, who similarly describes the dolphin at Poroselene in his *Halieutica* (5.459–518). That poem addresses Antoninus (Marcus Aurelius) and his son (Commodus) as co-rulers and therefore seems to have been published sometime between AD 177 and 180.[7] Although there is no reason to believe that Oppian witnessed the spectacle at Poroselene personally (his

[1] See Wellmann (1895).

[2] Keydell (1937). Keydell's arguments are accepted by Scholfield (1958) xxiii and have not been seriously challenged. Richmond proposes tentatively (and needlessly, see below) that Aelian may have relied on Leonidas only through a later intermediary source, but admits that this conclusion cannot affect the arguments for the date of Leonidas's work *ca.* AD 150 ((1973) 29–32 and 36–37 n.22).

[3] Kroll (1925); Zucker (2008) 503. Benedetti (2005) 5–6 offers salient observations about the value of Keydell's study while expressing surprise that, with the exceptions of Scholfield (1958) and Richmond (1973), it has not received the attention it obviously merits.

[4] See, for example, Olson (2007) 73 n.110 for the claim that Leonidas 'most likely dates to c. 100 BCE' or the even more confused account in Scarborough (2015) 56, especially n.16. The latter erroneously attributes the same notions to Richmond (1973) (which views are discussed below).

[5] Ael. *NA* 2.6: λέγει δὲ καὶ Βυζάντιος ἀνήρ, Λεωνίδης ὄνομα, ἰδεῖν αὐτὸς παρὰ τὴν Αἰολίδα πλέων ἐν τῇ καλουμένῃ Πορoσελήνῃ πόλει δελφῖνα ἠθάδα καὶ ἐν λιμένι τῷ ἐκείνων οἰκοῦντα καὶ ὥσπερ οὖν ἰδιοξένοις χρώμενον τοῖς ἐκεῖθι, 'A Byzantine man, by the name of Leonidas, says that while sailing along Aeolis he himself saw in a city called Poroselene a tame dolphin living in the harbour and interacting with the inhabitants there as if they were his very close friends'. Except where otherwise indicated, translations are my own. For the text of Aelian I employ the recent Teubner edition of García Valdés et al. (2009), and likewise for Oppian's *Halieutica* the Teubner edition of Fajen (1999). I note that the recent editors of the *NA* have chosen to renumber some chapters. In order to avoid confusion, I have retained the numbering used by Hercher (and subsequently Scholfield) and I give the new numbering in square brackets (this applies primarily to passages in book 12, for reasons discussed further below). For additional texts, unless noted otherwise, I have used the same editions as the *TLG*.

[6] Keydell (1937) 431–32 (citing earlier scholarship in support), with Paus. 3.25.7.

[7] Oppian, *Halieutica* 2.680–84 and 4.4–10. Commodus was awarded the title *Imperator* already in late November of 176, but the title *Augustus* only in the following year.

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account is clearly indebted to Leonidas), that is not sufficient cause to doubt his claim that it had been possible to observe it in his own lifetime (5.459: οὔτι παλαιόν, ἐφ' ἡμετέρῃ δὲ γενέθλῃ).[8]

Leonidas' *Halieutica* seems then to have been in wide circulation already within a generation of its composition sometime around AD 150 and the work remained popular into the third century. Athenaeus names Leonidas as among only three (or perhaps even two) authors of prose treatises on fishing known to him.[9] Although some scholars continue to claim otherwise, nothing suggests Athenaeus actually made use of Leonidas for any of the halieutic material in his *Deipnosophistae*.[10] Aelian, on the other hand, in his epilogue not only names Leonidas, together with Demostratus and a Metrodorus of Byzantium (who he alleges is the father of Leonidas), as among the authors most skilled in the halieutic art but also seems to have relied on him for a good deal of material in the *NA*.[11] Aelian only explicitly attributes four accounts to Leonidas (2.6, 2.50, 3.18 and 12.42), but it is probable that many additional passages are taken from the same source. It has been well demonstrated that while Aelian strives for an apparent lack of order in his miscellany by weaving together discrete passages from multiple sources treating different subjects, with respect to the use of individual sources his habits of composition are often less varied. He frequently borrows multiple passages more or less in their original order.[12] Furthermore, unmistakable similarities between passages in Aelian indebted to Leonidas and material in Oppian's *Halieutica* indicate that the poet independently borrowed from Leonidas, while clusters of related passages suggest that this borrowing may have been extensive.

The only serious attention that has been paid to Leonidas has concerned primarily trying to determine more precisely which passages in Aelian and Oppian derive from him.[13] The question of Leonidas' sources, on the other hand, has received almost no attention. By the middle of the second century AD there existed diverse accounts that collected or treated material related to fish and fishing. Careful study of the texts of authors ranging

[8] So already Marx (1889) 23, but demonstrated in detail by Wellmann (1895) 169–71 and supported by Keydell (1937) 417 and 430–31 and, more recently, Richmond (1973) 32 n.8.

[9] Ath. 1.13c, where the MSS of the epitome name only Seleucus of Tarsus and Leonidas, but a quotation of Athenaeus given by the *Suda* includes an otherwise unknown Agathocles of Atrax (κ 1596).

[10] Olson, for example, asserts that Leonidas is 'probably' used by Athenaeus ((2007) 73 n.110, *ad.* Ath. 1.13c), but he is apparently unaware of Keydell's arguments and subsequent scholarship. It seems that Athenaeus considered Leonidas' treatise, like Oppian's poem, which he similarly acknowledges without ever quoting, already 'too accessible' for his purposes; see Richmond (1973) 3.

[11] Ael. *NA* epilogue: τί πρὸς ταῦτα Κέφαλοί τε καὶ Ἱππόλυτοι καὶ εἴ τις ἐν ὄρεσιν ἀγρίοις θηρία μετελθεῖν δεινὸς ἕτερος ἢ αὖ πάλιν τῶν ἐν ὑδροθηρίαις δεινῶν Μητρόδωρος ὁ Βυζάντιος ἢ Λεωνίδης ὁ τούτου παῖς ἢ Δημόστρατος ἢ ἄλλοι τινὲς θηραταὶ ἰχθύων οἱ δεινότατοι, πολλοὶ ναὶ μὰ Δία;, 'What do the Cephaluses and Hippolytuses or anyone else skilled in hunting in the wild mountains have to say about these things? Or again, of those who are expert in the halieutic art, Metrodorus of Byzantium, or his son Leonidas, or Demostratus, or any of the others (and god knows there are many) most skilled at catching fish?' Although scholars have been willing to credit Aelian's suggestion that Leonidas inherited his interests from his father (see, for example, Scarborough (2015) 56 n.16: 'Leonidas of Byzantium was the son of a famous ichthyologist'), scepticism is probably warranted. Nowhere else does Aelian cite this Metrodorus and he is otherwise completely unknown. On Demostratus, see Wellmann (1895), but with Keydell (1937) 432 n.2.

[12] Aelian's treatment of sources has been thoroughly documented, especially (but not always uncontroversially) by Wellmann in a series of articles in *Hermes* (1891a; 1891b; 1892; 1895; 1896; 1916). More recently, see Scholfield's comments in the introduction to his Loeb edition (Scholfield (1958) xiv–xxiv), and, on Aelian's passages treating fish lore, Richmond (1973) 28–32. Finally, Benedetti (2005) offers a detailed treatment of Aelian's sources for accounts that share material with book 1 of Oppian's *Halieutica*, and although demonstrating (convincingly) that a much more nuanced picture of Aelian's use of sources is required, it does not challenge the orthodox account of his basic method of composition, which he himself describes in his epilogue as 'weaving together varied accounts in a varied fashion' (ἀνέμιξα δὲ καὶ τὰ ποικίλα ποικίλως). On this aesthetic of *poikilia*, see especially Smith (2014) 47–66.

[13] In addition to Wellmann and Keydell, see especially Richmond (1973) 28–32.

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from pseudo-Ovid to Plutarch shows that several of these relied on a number of the same now-lost secondary sources. These sources included at least one important catalogue as well as a popular zoological compendium.[14] Fortunately the exact nature of these sources and the hopelessly complex arguments involved in their reconstruction need not concern us (at least for the most part). It is clear, however, that for their scientific knowledge all of these compilations relied chiefly on Aristotle, albeit often indirectly through works like Aristophanes of Byzantium's third-century BC *Epitome* (which drew primarily from Aristotle's *Historia animalium* but also included some additional early Peripatetic research) or (if it is not in fact identical to the *Epitome*) the pseudo-Aristotelian *Zoika* attested primarily by Athenaeus.[15] This is hardly surprising or controversial: it has often been noted how little later scholarship seems to have added to Aristotle's ichthyological knowledge. Aristotle's Peripatetic successors, it is suggested, largely avoided that area of research and, setting aside Theophrastus and his curious little treatise *On Fish* (that live on dry land),[16] only a single such author, Clearchus of Soli, is known to have written on the subject (I treat these topics in greater detail below). Leonidas, too, may have included in his work material drawn from Aristotle, but I would suggest that much of his interest for readers like Aelian stemmed rather from his having drawn on a wider range of source material.[17] That material included, contrary to all expectations, a series of reliable, first-hand accounts that seem to have been the product of a systematic programme of scientific research conducted in the Red Sea.

III. The masked puffer

NA 3.18 purports to describe a fish of the Red Sea: the φύσαλος, or 'puffer'. I give the recent Teubner text followed by A.F. Scholfield's Loeb translation:

> Ἐν τῇ Ἐρυθρᾷ θαλάττῃ κόλπω δὲ τῷ Ἀραβίῳ ἰχθὺν Λεωνίδης ὁ Βυζάντιος γενέσθαι φησί, κωβιοῦ τοῦ τελείου μείονα οὐδὲ ἕν· ἔχειν δὲ οὐδὲ ὀφθαλμοὺς αὐτὸν οὔτε στόμα ἐν νόμῳ τῷ τῶν ἰχθύων. προσπέφυκε δέ οἱ βράγχια καὶ σχῆμα κεφαλῆς, ὡς εἰκάσαι, οὐ μὴν ἐκμεμόρφωται εἶδος· κάτω δὲ ἄρα ὑπὸ τῇ γαστρὶ αὐτῷ ἐντέθλασται τύπος κολπώδης ἡσυχῇ, καὶ ἐκπέμπει σμαράγδου χρόαν. τοῦτον οὖν εἶναι καὶ ὀφθαλμόν οἵ φησι καὶ στόμα. ὅστις δὲ αὐτοῦ γεύσεται, σὺν τῷ κακῷ τῷ ἑαυτοῦ ἐθήρασεν αὐτόν. καὶ τῆς διαφθορᾶς ὁ τρόπος, ὁ γευσάμενος ᾤδησεν, εἶτα ἡ γαστὴρ κατέρραξε, καὶ ὁ ἄνθρωπος ἀπόλωλε. δίδωσι δὲ καὶ αὐτὸς ἁλοὺς δίκας. πρῶτον μὲν ἔξω τοῦ κύματος γενόμενος οἰδαίνει, καὶ εἴ τις αὐτοῦ ψαύσοι, ὃ δὲ ἔτι καὶ μᾶλλον πίμπραται. καὶ εἴ τις ἐπιμείνη ψαλάττων, γίνεται πᾶς ὑπὸ σήψεως διαυγέστατος, ὡς ὑδεριῶν· εἶτα τελευτῶν διερράγη. εἰ δὲ αὐτὸν ἐθέλοι τις ἔτι

[14] On these sources (and the complex arguments involved in their reconstruction), see most recently Richmond (1973) 3–26 and Benedetti (2005).

[15] On the *Epitome*, see Hellmann (2006). The relationship between the *Epitome* and the *Zoika*, which Athenaeus ascribes to Aristotle and refers to as περὶ ζωικῶν ἢ ἰχθύων or simply περὶ ζωικῶν, remains unclear. For the view that the latter was merely a version of the former, see Stefani (1904) 428–40, with discussion of earlier scholarship, and, more recently, Kullmann (1998) 131. For arguments that the *Zoika* was a separate and perhaps slightly earlier Peripatetic collection, see Kroll (1940) 28–30 and, more recently, Berger (2012).

[16] For introduction, text and commentary, see Sharples (1992). The surviving chapters of this treatise are concerned only with the phenomena of fish emerging onto dry land and burrowing there. Sharples is likely correct in concluding that the treatise is largely complete and was not part of a larger work devoted to fish or aquatic animals.

[17] It has already been suggested that Leonidas made use of Clearchus of Soli (see below), and in a future article I will argue that he also made use of another third-century BC treatise, Antigonus of Carystus' enigmatic *Περὶ λέξεως*.

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> ζῶντα εἰς τὴν θάλατταν μεθεῖναι, ὃ δὲ ἐπινήχεται δίκην κύστεως ἀρθείσης πνεύματι. καί φησιν ὅτι ἐκ τοῦ πάθους φύσαλον ἐκάλουν αὐτόν.
>
> Leonidas of Byzantium asserts that there occurs in the Red Sea a fish of exactly the same size as a full-grown goby: it has neither eyes nor mouth after the manner of fishes, but grows gills and a kind of head, so far as one can guess, though its form is not perfectly developed. But lower down beneath its stomach is a slightly indented depression which emits the colour of an emerald; and this, they say, is both its eye and its mouth. But anyone who eats it has fished to his own undoing. And this is how he is destroyed: the man who has eaten it swells up; then his stomach bursts and he dies. But the fish itself when caught pays for it, for first, when it is out of the water, it swells, and if one touches it, it swells even more; while if one continues to handle it, it turns to corruption and becomes quite translucent, like a man with dropsy, and finally bursts. If however one is prepared to return it still alive to the sea, it swims on the surface like an inflated bladder. Leonidas says that in consequence of this property men call it the 'inflater'.

This strange account has received surprisingly little attention from classicists, in part, I suspect, because they have had no idea what to make of it. Nevertheless, it was of interest to the earliest Renaissance naturalists, for whom the description and categorization of species inevitably involved attempting to identify their Greek and Latin names and to record the claims of ancient authorities. In the sixteenth century, Guillaume Rondelet famously attempted to identify Leonidas' *phusalos* with a marine polychaete worm, the sea mouse (*Aphrodita aculeata*).[18] Besides being the source of much subsequent confusion with respect to the sea mouse,[19] Rondelet's identification is impossible, and so too are a host of subsequent proposals, for example, that Leonidas described a jellyfish or a marine hydrozoan like the Portuguese man-of-war (*Physalis physalis*).[20] The majority of early commentators suspected rather that Leonidas' description derived from knowledge of some kind of puffer fish, even if the details did not correspond to any known species.[21] That apparent disjunction leads no less an authority than D'Arcy Thompson to confidently dismiss Leonidas' description as a 'fabulous account'. Thompson further suggests that any distant connection to reality is owed to the account relying in part on a description of a freshwater Nile species, the Fahaka puffer or globefish, *Tetraodon lineatus*.[22] This species was frequently left

[18] Rondelet (1554) 428–29.

[19] Hubbell (1999) 215–19.

[20] See, for example, François Désiré Roulin's comments in his appendix to Vincent (1847) 562. Remarkably, Thee (1984) 240–41 treats this identification as plausible.

[21] Schneider (1789) 346–47.

[22] Thompson (1947) 280, *s.v.* φύσαλος. Thompson contributed many of the entries for fish names in LSJ, and he is likely responsible for the definition given for φύσαλος: 'II. a poisonous *fish which puffs itself out*, prob. *Tetrodon*, Ael. *NA* 3.18'. For *Tetraodon lineatus* and likewise all other fish species discussed below, see the online database *FishBase*, www.fishbase.org. For other species of marine life, see *SeaLifeBase*, www.sealifebase.org. All of the Red Sea fish and invertebrates discussed below can also be found in Lieske and Myers (2004), an authoritative illustrated guide to the reef fauna of the Red Sea. The term φύσαλος could also be used for whales (perhaps referring to their blowholes), see LSJ, *s.v.* III (citing Oppian, *Halieutica* 1.368 and Ael. *NA* 9.49). Finally, the word is used by Lucian (*Philops.* 12; *De dipsadibus* 3) to refer to a mysterious creature, described by LSJ, *s.v.*, as 'a kind of *toad said to puff itself up* even to bursting, and to have poisonous breath'. Lucian does not give that information and its ultimate origin deserves explanation, albeit in a different venue (more immediately, LSJ clearly relies on Passow's *Handwörterbuch*, *s.v.*: 'eine Krötenart, die sich aufblasen u. einen giftigen Hauch haben soll'). There are no ancient descriptions of the Nile puffer but, as discussed by Thompson (1947) 278–79 (*s.v.* φῦσα), it is possible that this fish was referred to by the name φῦσα, which appears in lists of Egyptian fish names given by Athenaeus (7.312f) and Strabo (17.2.4c823) and is the subject of another curious (but unrelated) account in Aelian (*NA* 12.13). Finally, it is named together with φύσαλος in MSS V and D of Sextus Julius Africanus' *Cesti*, where τὸν φυσαλὸν, ἢ φύσας ποταμίας is inserted at I 2.88 (Vieillefond (1970)).

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stranded by the annual flood and was consequently well known to the Egyptians, who represented it accurately already in the third millennium BC on the Sixth Dynasty tomb of Mereruka at Saqqara and later on a well-known wall painting from the Eighteenth Dynasty tomb of Nebamum at Thebes, now in the British Museum (see Supplementary fig. 1).[23]

Given the almost complete dearth of comment on this strange and fascinating passage, it would seem that most subsequent scholars have been content with Thompson's verdict.[24] His theory, however, is improbable. Unlike the fish described by Leonidas, the Fahaka puffer is obviously not a Red Sea species, and in that respect Leonidas' account seems to have been explicit. In the first sentence of Aelian's account, Scholfield follows Rudolf Hercher in excluding κόλπω δὲ τῷ Ἀραβίῳ as an intrusive gloss, but as seen by the editors of the more recent Teubner, that detail is important, since Ἐρυθρὰ θάλαττα could denote the Indian Ocean more generally. Bodies of water within it like the Persian Gulf were sometimes further distinguished and already in Herodotus the modern Red Sea is specified by the name Arabian Gulf (2.11). That usage remains common in later authors (see below), with the manuscript reading in Aelian suggesting that Leonidas' source relied on research localized specifically in the modern Red Sea. Even if one were to assume, however improbably, that the Fahaka puffer could have inspired a fictional account of a local Red Sea fish, Leonidas' description hardly matches the Nile species, which is armoured conspicuously with spines and is considerably larger than even the largest Mediterranean goby.

A much better explanation is available: Leonidas drew on a relatively accurate, first-hand account of a puffer in an altogether different genus and an actual Red Sea fish, the masked puffer, *Arothron diadematus*. This little species is especially common in the northern Red Sea and is notably smaller than the Fahaka puffer. It is in fact the size of the largest Aegean gobies and therefore matches well the curiously specific indication given by Leonidas (κωβιοῦ τοῦ τελείου μείονα οὐδὲ ἕν).[25] Living over coral in lagoons and on fringing reefs, the masked puffer is commonly encountered in shallow coastal waters like those near northern Red Sea resorts where fishermen and tourists sometimes find it entertaining to remove the fish from the water before letting it go, inflated with air. The experience is, as noted by Leonidas, not infrequently fatal for the poor puffer fish.[26]

The masked puffer, like most species of puffer fish, also contains, especially in its organs, high concentrations of tetrodotoxin, a lethal paralytic neurotoxin. The faunal evidence from sites such as Myos Hormos proves that the masked puffer was regularly captured by ancient fishermen in the northern Red Sea and we can assume that they would have been familiar with its toxicity, either because of occasional accidental consumption or because the fish was sometimes eaten despite, or indeed because of, the risks, as with

[23] The Fahaka puffer was first described scientifically by Hasselquist (1762) 441–46 and then more fully by Geoffroy Saint-Hilaire (1809) 19–37, who also gives an account of its behaviour and capture. More recently, see the concise account given by Brewer and Friedman (1989) 80–81, with illustrations.

[24] See most recently Zucker (2008) 503: 'a mysterious poisonous fish (a kind of globe-fish) of the Red Sea'.

[25] Gobies constitute the largest family of marine fish and ancient sources rarely attempt to distinguish between the dozens of common Mediterranean gobies or the many closely related species of blennies (Ath. 7.288a describes the rarely attested βλέννος as resembling the κωβιός). The masked puffer reaches a maximum length of only 30cm, but many Mediterranean gobies and blennies are comparatively tiny and most are smaller than 10cm in length. A few common species, however, are a good deal larger: the tompot blenny (*Parablennius gattorugine*), for example, can reach the same maximum length as the masked puffer, while the grass goby (*Zosterisessor ophiocephalus*) is only slightly smaller (25cm). For the ancient evidence, see Thompson (1947) 137–39, *s.v.* κωβιός.

[26] When inflated with air on the surface, the pressure differential prevents the puffer from deflating, for which reason Red Sea guides frequently implore tourists not to handle the fish. For similar treatment of the Nile puffer, see Brewer and Friedman (1989) 80: 'Nile fishermen are able to make the fish inflate by rubbing its belly or blowing in the fish's mouth like a balloon. On occasion, usually as a means to startle unsuspecting foreigners, the fishermen will strike an inflated fish with a large stone or hammer; the sound that is emitted resembles that of a small-caliber firearm'.

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the Japanese fugu.[27] In cases of fatal tetrodotoxin poisoning, the victims most often die of asphyxiation through paralysis of the diaphragm, but they first suffer severe gastrointestinal distress. In Leonidas' account, the effects of the toxin mirror more directly the nature and experience of the undersea creature itself: the fisherman who eats the puffer fish is afflicted by swelling in his belly until it bursts and he dies.

A far more serious problem remains: Leonidas' description of the physical appearance of the fish at first glance seems unrealistic. But treating the passage as mere invention makes it no easier to explain. It is less obviously fantastic than it is incomprehensibly strange. If Leonidas' source claimed that the fish had no eyes or mouth on its head, but rather a kind of opening below its belly that performed both those functions, then the difficulties in identifying this fish would seem irresolvable. There remains an attractive solution, however. The masked puffer has an odd mouth that is fused into a kind of beak and protruding eyes adjacent to what look like prominent bony brows, but more importantly both its eyes and mouth are 'masked' by black bands against an otherwise grey-green colouration (see Supplementary fig. 2). The *NA* is famously rife with textual corruptions, interpolations and misguided interpretations, many owed to Aelian himself, others no doubt inherited from his sources or the product of his later manuscript tradition.[28] An obvious hypothesis suggests itself: an original account that described the fish's eyes and mouth as 'masked' or 'hidden' or 'not visible' was misunderstood as suggesting that these features were entirely absent (ἔχειν δὲ οὔτε ὀφθαλμοὺς αὐτὸν οὔτε στόμα ἐν νόμῳ τῷ τῶν ἰχθύων). Indeed, the immediate subsequent assertion that the fish has gills and a head typical of fish (προσπέφυκε δέ οἱ βράγχια καὶ σχῆμα κεφαλῆς), but that 'its form is otherwise underdeveloped' (οὐ μὴν ἐκμεμόρφωται εἶδος), both implies that the fish *does* have eyes and a mouth on its head and also aptly describes the strange proportions of the masked puffer, with a head that is large and well developed but a body that appears oddly truncated or withered behind its pelvic and dorsal fins.

What κάτω δὲ ἄρα ὑπὸ τῇ γαστρὶ αὐτῷ ἐντέθλασται τύπος κολπώδης ἡσυχῇ ('Beneath its belly there is an impression, slightly indented') intends to describe should perhaps remain an open question, and καὶ ἐκπέμπει σμαράγδου χρόαν ('and emits the colour of an emerald') is even more mysterious. If this passage is ultimately derived from a well-informed account of the masked puffer, however, it is certainly worth mentioning that this fish exhibits a peculiar and noteworthy behaviour. Finding a sheltered spot among rocks or reef it begins to secrete an odorous and highly viscous sperm from its lower anal cavity. The fish then proceeds to build with this sperm a nest in which it shelters until, after approximately a week, the nest becomes mouldy, at which point the fish moves and begins the process anew.[29] Aelian's σμαράγδου χρόαν likely refers to the oily secretion itself, which would have been observed when handling the fish (even if the phrase itself

[27] At low enough concentrations, the effects of tetrodotoxin are reportedly pleasant and it is not improbable that the masked puffer was sometimes carefully prepared and consumed in antiquity by inhabitants of the Red Sea zone. Interestingly, Hamilton-Dyer (2011) 260 notes that bones of pufferfish of the genus *Arothron* are (together with those of porcupinefish) 'a consistent presence' among the faunal remains excavated from Roman period layers at Quseir al-Qadim, site of the ancient Myos Hormos. She considers the possibility that these pufferfish may have been consumed but concludes that it is more likely that they were discarded as by-catch. A few remains belonging to family Tetraodontidae were recovered too from Ptolemaic, early Roman and late Roman contexts at Berenike; see Van Neer and Ervynck (1998) 362. I can find no direct ethnographic parallels from the Red Sea, but it is perhaps worth noting that the Nile puffer, although generally not eaten in early modern Egypt, was traditionally consumed by the Dinka people of Sudan (Sandon (1950) 60).

[28] Beyond describing Aelian as 'at times a careless copyist', Scholfield (1958) xxiv has little to say about the text; but Eichholz (1960) 219, commending Scholfield's restraint when dealing with Aelian's text, follows earlier commentators in describing it as 'riddled … with corrupt passages and packed with interpretations'.

[29] It is tempting to suppose that for Leonidas' source, comparison with the goby was also suggested by a shared propensity for nest-building, although Aristotle attributes such behaviour only to the φυκίς, a small fish that Cuvier identified as a goby but is more probably a kind of wrasse; see Thompson (1947) 276–78, *s.v.* φύκης.

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is awkward and the text potentially corrupt).[30] Scholfield translates the final claim, τοῦτον οὖν εἶναι καὶ ὀφθαλμόν οἵ φησι καὶ στόμα, as if reading φασι ('and this, they say, is both its eye and its mouth'), but φησι suggests rather an attempt to explain the import of the preceding description of the fish's anal cavity by linking it to an initial misunderstanding that the fish has neither eyes nor mouth on its head. As such the entire phrase resembles an intrusive gloss, the form φησί is a standard feature of such glosses ('[the author] means/is saying that …'), but it is perhaps just as probable that this misguided interpretation is owed rather to Aelian.

IV. Aelian and the marine fauna of the Red Sea

This identification with the masked puffer does not require much in the way of special insight and it is perhaps surprising that it has not been proposed already, although that fact too can be explained by the history of scholarship. For those early naturalists interested in identifying ancient Greek and Latin fish names, marine species of the Red Sea were virtually unknown. The masked puffer was described by Eduard Rüppell only in the 19th century, long after debates about ancient identifications had been ossified in standard references like Johann Gottlob Schneider's *Synonymia piscium graeca et latina* (1789), a revised and expanded edition of a popular catalogue originally compiled by Peter Artedi more than 50 years earlier. Consequently, the masked puffer (and many other Red Sea species) remained unknown to later scholars interested in ancient Greek fish names, including Thompson, whose *Glossary* remains the standard reference, though long out of date.[31]

Nevertheless, Thompson could have decoded Aelian's account of the masked puffer had he not assumed it to be fantastic, as demonstrated by his discussion of a second passage from the same book of the *NA* (3.28):

> Γίνεται δὲ ἐν τῇ Ἐρυθρᾷ θαλάσσῃ ἰχθῦς, καὶ ὅσα γε εἰδέναι καὶ ἐμέ, ἔθεντο Περσέα ἐπιχώριοι ὄνομα αὐτῷ. Καὶ οἱ μὲν Ἕλληνες αὐτὸν οὕτω, καλοῦσι δὲ καὶ Ἄραβες ὁμοίως τοῖς Ἕλλησι· Διὸς γὰρ υἱὸν καὶ ἐκεῖνοι ἄδουσι τὸν Περσέα, καὶ ἀπ' αὐτοῦ γε τὸν ἰχθῦν ὑμνοῦσι λέγεσθαι. Μέγεθος μὲν οὖν ἐστι κατὰ τὸν ἀνθίαν τὸν μέγιστον, ἰδεῖν δὲ ὅμοιος λάβρακι· γρυπός γε μὴν ἡσυχῇ οὕτω, καὶ ζώναις πεποίκιλται χρυσῷ προσεικασμέναις· ἄρχονται δὲ ἀπὸ τῆς κεφαλῆς ἐπικάρσιοι αἱ ζῶναι, καὶ εἰς τὴν γαστέρα καταλήγουσι. Πέφρακται δὲ ὀδοῦσι μεγάλοις καὶ πυκνοῖς. Λέγεται δὲ ἰχθύων περιεῖναι ῥώμῃ τε σώματος καὶ βίᾳ· ἀλλὰ οὐδὲ τόλμης οἱ ἐνδεῖ. Θήραν δὲ αὐτοῦ καὶ ἄγραν εἶπον ἀλλαχόθι.
>
> There occurs in the Red Sea a fish, and, as far as I know, locals have given it the name Perseus. Thus the Greeks call it, and Arabs in the same fashion as the Greeks. For they also consider Perseus the son of Zeus, and it is from him that they say the fish takes its name. Its size is equal to that of the largest *anthias*; in appearance it resembles a sea-bass; its nose is somewhat hooked, and it is adorned with stripes that are like gold, and these stripes start at the head running at a right angle to it and leave off at the

[30] In photographs the masked puffer's nest often appears to have a peculiar greenish colour but I have been unable to confirm that this is due to the viscous sperm itself (rather than the mould), in which case the MS reading could perhaps be defended. Otherwise I suspect it hides an original reference to a foul semen or oily unguent (for example, σμῆγμα/σπέρμα αἰσχρόν).

[31] On other misidentifications in Thompson's *Glossary*, see, most recently, Lytle (2016). Needless to say, it remains a vast improvement over all previous discussions of Greek fish names, as demonstrated by, for example, Gossen (1935), whose discussions of fish names in Aelian are often ludicrous. For the *phusalos* he suggests (p. 158, no. 131) identification with one of the blind cusk eels (*Barathronus diaphonus*) a fish that bears no resemblance whatsoever to the description given by Leonidas and lives only at depths greater than 700m!

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belly. Its mouth is guarded by large and closely set teeth. It is said to be preeminent among fish for the strength and power of its body, and it does not lack daring. I have told elsewhere of how to fish for and capture it.

Finding nothing unbelievable about this account, Thompson sought the advice of the noted British Museum ichthyologist Ethylwynn Trewavas, who suggested identification with a species of the family Lutjanidae ('snappers').[32] The faunal evidence proves that species of Lutjanidae were commercially important in the northern Red Sea in antiquity: in the Roman period catches were even imported from coastal sites like Myos Hormos to relatively remote inland sites like Mons Porphyrites and Mons Claudianus, the latter a two- or three-day journey by donkey or camel from the coast.[33] One particular species, *Lutjanus bohar*, is especially large and powerful with prominent teeth and a famously voracious nature. As suggested by one of its common English names, red seabass, it bears a noteworthy resemblance to the ancient Greek *labrax*, the European seabass.[34] This fish remains commercially important in the northern Red Sea and Thompson further suggests that its common Arabic name – بوهر (*buhar*) – could explain the stem περ- in the Greek name, a possibility made more intriguing by an entry in Hesychius attesting a Red Sea fish name with the same stem but different termination: πέρσος.[35] A likely hypothesis is that in Aelian the characteristic Greek etymological interpretation has replaced the fish's original name (of non-Greek origin). Hesychius' entry would then likely be indebted, by way of an earlier Alexandrian lexicon, to the same original source as Aelian's account.[36]

More importantly, as seen already by Keydell and John Richmond, Aelian's immediate source is surely again Leonidas: the passage follows shortly after the account of the masked puffer and includes a number of features in common, notably a close physical description involving comparison of a Red Sea species with the maximum size of a common Mediterranean fish. Leonidas' account also must have included a description of how fishermen captured the Perseus fish.[37] Had Thompson realized the two accounts were connected, he might have been more hesitant to dismiss the first as fabulous.

Furthermore, Wellmann proposed that these two descriptions of Red Sea fish comprise the initial passages of a longer series of related accounts that resumes after a six-book hiatus at 10.13 and includes 10.20, 11.9, 11.21, 11.23–24, 12.25[24], 12.27[25], 15.8, 17.1, 17.6, 17.8 and 17.9. The key passage for Wellmann's argument is 17.1:

Ἀλέξανδρος ἐν τῷ περίπλῳ τῆς Ἐρυθρᾶς θαλάττης λέγει οὕτως· ὄφεις ἑορακέναι τετταράκοντα πηχῶν μῆκος, πλάτος καὶ πάχος κατὰ τὸ μῆκος δηλονότι, καὶ γένος καρκίνων, οἷς τὸ μὲν ὄστρακον τὴν περιφέρειαν εἶχε πανταχόθεν πόδα, καὶ χηλαὶ δὲ ἠρτημέναι μέγισται προείχοντο, ἐπιβουλεύεσθαι δὲ ὑπ' οὐδενὸς αὐτούς. τὸ δὲ αἴτιον, ἱεροὶ λέγονται Ποσειδῶνος.

[32] Thompson (1947) 197, *s.v.* Περσεύς.

[33] Though not abundant, remains of Lutjanidae are present at both Mons Claudianus (Hamilton-Dyer (2001) 283–89) and Mons Porphyrites (Hamilton-Dyer (2007a) 149–50). They appear more regularly at Myos Hormos (Hamilton-Dyer (2011a) 256–69).

[34] *Lutjanus bohar* commonly reaches 75cm in length and 10kg in weight. Unfortunately, the sources do not allow for a precise identification of ancient Greek *anthias*, although the name could be used of a similarly large fish (Thompson (1947) 14–16, *s.v.*).

[35] π 2007 Hansen: πέρσος· [ὁ] ἰχθὺς ποιὸς ἐν Ἐρυθρᾷ γινόμενος.

[36] Hesychius' immediate source is likely the second-century AD lexicon of Diogenianus, but that work drew in turn on earlier Alexandrian lexica. For a brief overview, see Dickey (2007) 88–90.

[37] Aelian's claim that he has elsewhere related how to catch the Perseus fish finds no support in our text of the *NA* (perhaps he intended to give that account elsewhere but failed to do so; less charitably, the claim is copied from his source) nevertheless it proves that Leonidas included a description of its capture.

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> Alexander in his *Periplus of the Red Sea* says that he has seen snakes twenty meters long, with a width and thickness in proportion to their length, and a type of crab with a shell that is a foot across on every side and attached to it are great claws projecting out. But no one hunts them. The reason: they are said to be sacred to Poseidon.

Wellmann identifies this Alexander as Alexander of Myndus, best known for having written a popular *Περὶ ζῴων*, one book of which was dedicated to birds.[38] Wellmann argues that all of Aelian's Red Sea material is drawn from this *Periplus*, which he suggests was, despite its name, a kind of zoological and paradoxographic compendium. Aelian, according to Wellmann, has merely reproduced Alexander's citation of Leonidas at 3.18 (and likewise those of Pythagoras at 17.8 and 17.9).[39]

Wellmann's hypothesis can be rejected. First, even if scholars remain surprisingly willing to accept the identification,[40] there is little reason to believe that the Alexander cited in 17.1 is Alexander of Myndus or that the *Periplus* cited in the passage essentially resembled in its organization and interests the Myndian's zoological and paradoxographic work. To the contrary, no other source ascribes a *Periplus* to Alexander of Myndus, while on four different occasions when Aelian cites that Alexander as an authority he is careful to identify him as ὁ Μύνδιος (3.23, 4.33, 5.27, 10.34). Indeed, there is nothing in 17.1 that is characteristic of the Myndian's other zoological fragments.[41] Second, Wellmann's argument that Aelian found Leonidas cited already by Alexander of Myndus relies on related arguments about the early date of Leonidas discussed above. Since Leonidas belongs to the mid-second century AD, he is too late to have been used as a source by Alexander of Myndus, for whom citations by Ptolemy Chennus and Plutarch provide a secure *terminus ante quem ca.* AD 100.[42] Third, what Wellmann sees as a single series is in fact a diverse set of passages united only by geography (they pertain to the *eruthra thalassa* broadly conceived) and the wide range of interests ascribed to Alexander of Myndus. If the author of the Red Sea *Periplus* cited by Aelian is disassociated from Alexander of Myndus, or if passages owed to Leonidas are removed (as they must be), the unity of Wellmann's series disappears.

This is not merely an exercise in deconstruction. Setting aside Wellmann's hypothesis allows us to see a more coherent pattern. The Red Sea passages that are more certainly owed to Leonidas (3.18 and 28) may have been of paradoxographic interest but they are focused on marine fauna and built on a core of careful observation that we might describe as 'scientific'. As such they are distinct from 15.8, 17.1, 17.6, 17.8 and 17.9. The first of these gives a description of Indian pearl oysters that is ultimately owed to Megasthenes, but also

[38] Wellmann (1891b) remains the most thorough discussion of Alexander of Myndus and the only collection of his zoological fragments, but Richmond (1973) 6–7, 23 n.41, 45 n.1 and Arnott (1987) offer cautionary remarks and a number of important corrections. See, most recently, Asirvatham (2012) (= *BNJ* 25) and González Ponce (2013) (= *FGrH* 2201).

[39] Wellmann (1891b) 565–66; restated in Wellmann (1894).

[40] Asirvatham (2012) closely follows Jacoby, who considered Wellmann's identification 'sehr wahrscheinlich' (*FGrH* 25); González Ponce (2013) seems to similarly consider Wellmann's identification probable, but he tentatively proposes that we could instead identify the author of the *Periplus* cited by Aelian not with Alexander of Myndus but rather with the Indian Ocean merchant used as a source by Marinus of Tyre, as attested by Ptolemy (*Geog.* 1.14). That hypothesis is in my view well worth considering, and would imply that *NA* 17.1 reflects not a paradoxographic and zoological collection but rather a single notice distilled from a work composed by an Indian Ocean merchant and otherwise perhaps more closely resembling the anonymous first-century AD *Periplus Maris Erythraei.*

[41] On the veracity of the Myndian's zoological accounts, especially his descriptions of birds, see Arnott (1987).

[42] See Plut. *Mar.* 17.3 and for Ptolemy Chennus, *BNJ* 25 F4 (*ap.* Phot. *Bibl.* Cod. 190.147b). The passage in Plutarch suggests a relatively secure *terminus ante quem* of 102 BC. Wellmann (1891b) 539–40 and (1892) offer a number of arguments for dating Alexander closer to the middle of the first century AD, but these are highly speculative and should carry little weight, as noted already by Arnott (1987) 23–24 and 28–29 n.4 (but *cf.* González Ponce (2013), apparently accepting Wellmann's dating).

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includes additional material collected by Juba.[43] The account derived from Megasthenes is of no scientific value and bears little resemblance to 3.18 and 3.28. The passage attributed to the *Periplus* of Alexander at 17.1 is obviously not indebted to Leonidas or his source, nor are any of the subsequent passages: 17.6 is a kind of list of remarkable creatures citing a mélange of sources, while 17.8 and 17.9 are accounts of Red Sea land animals made (originally) by Pythagoras, a third-century BC Ptolemaic official.

Aelian could have found none of 15.8, 17.1, 17.6, 17.8 and 17.9 in the work of Leonidas. The same is decidedly not the case, however, for the earlier part of Wellmann's series. As I will show, all but one of these describe actual marine fauna of the northern Red Sea and Aelian surely owes them to Leonidas. The first, 10.13, offers a fundamentally lucid account of Red Sea pearl oysters (the black-lip oyster, *Pinctada margaritifera*, and the closely related *Pinctada radiata*) and their exploitation, even if the passage shows familiar signs of having been embellished by Aelian. While the pearl industry is more commonly associated in our ancient sources with other regions of the Indian Ocean, especially the Persian Gulf and areas off the coasts of India (including the Gulf of Mannar between India and Sri Lanka), the account in 10.13 is independent. As seen by the editors of the recent Teubner, the manuscript reading ἥπερ οὖν ἐστιν ὁ Ἀράβιος, again excluded by Hercher, clearly intends to specify the modern Red Sea. That detail is significant, perhaps especially because scholars, noting the apparent absence of literary evidence, have sometimes argued that pearl fishing was not practised in the Red Sea in antiquity, despite two early first-century AD inscriptions from the Eastern Desert that attest a certain Publius Juventius Rufus as 'chief mining magistrate' responsible for overseeing the production of 'emerald, peridot, pearl and of all the mines and quarries of Egypt'.[44] A range of additional evidence suggests that, as in more recent centuries, commercial pearl diving was practised in the Red Sea already in antiquity.[45] The faunal evidence especially shows that while overfishing and perhaps other factors have now made the black-lip pearl oyster relatively scarce in parts of the northern Red Sea,[46] in antiquity it was very abundant in shallow reef environments and exploited not only for its pearls but also as a food source. In the Roman period, for example, its shells appear in great quantities at inland sites like Mons Claudianus.[47] Aelian's description of the oyster itself is brief and at first glance problematic (10.13, tr. Scholfield):

[43] Megasthenes is not named but a similar account is ascribed to him at Arr. *Indica* 8.11–13. In his long account of pearls (*HN* 9.106–24), Pliny includes a related passage (111) that similarly fails to name Megasthenes.

[44] Both inscriptions were made by Rufus' freedman, a certain Publius Juventius Agathopous, who describes himself as the supervisor and administrator of the mines and quarries. The first inscription, from a sanctuary of Pan on the route from Myos Hormos to Coptos and dating to AD 11, indicates that at that time Rufus was also chiliarch of the Third Legion and governor of Berenike (*SEG* 20.670; *I.Pan* 51, lines 2–10): ἐπεὶ Ποπλίου/ Ἰουεντίου Ῥούφου χιλιάρ/χου τῆς τερτιανῆς λε/γεῶν(ος) καὶ ἐπάρχου Βερνίκη/ς καὶ ἀρχιμεταλλάρχου/ τῆς σμαράγδου καὶ βα/ζίου καὶ μαργαρίτου καὶ/ πάντων τῶν μετάλλων/ τῆς Αἰγύπτου. The governorship of Berenike would have meant that Rufus was conveniently placed to oversee not just the mines and quarries of the Eastern Desert but also the production of peridot and the harvesting of pearls from the Red Sea. The second text (*I.Ko.Ko.* 41; *SEG* 27.1112; *OGIS* 660) is from another sanctuary of the same god, but this one in Wadi Hammamat and dating to the fifth year of the reign of Tiberius (AD 18).

[45] See, for example, Donink (1998) 80–81 and 119–21, and Schörle (2015) 46–49, both with references to earlier bibliography. Stressing the absence of any literary evidence for ancient pearling in the Red Sea, Schneider (2016) offers a highly speculative argument that Rufus was responsible for overseeing the mining of a mineral referred to as 'pearl'.

[46] Abdel Razek et al. (2011).

[47] Myos Hormos: Hamilton-Dyer (2011a) 269–76; Mons Claudianus: Hamilton-Dyer (2001) 290–92; Mons Porphyrites: Hamilton-Dyer (2007a) 156–58. Pearl oyster shells are also present but less common in excavated contexts at Berenike (Van Neer and Ervynck (1998) 354–55), but Schörle (2015) 48 notes the existence of prominent shell middens adjacent to the ancient harbour that have yet to be investigated.

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καὶ τὰ ὄστρεα δὲ τὰ τῆς Ἐρυθρᾶς θαλάσσης ἥπερ οὖν ἐστιν ὁ Ἀράβιος, τῆς αὐτῆς ἀγλαΐας ἄμοιρα οὐκ ἔστι· ζῶναί τε γὰρ περιέρχονται φλογώδεις αὐτά, καὶ φαίης ἂν θεασάμενος τὴν ἶριν αὐτὰ μιμεῖσθαι τῇ κράσει τῶν ποικίλων χρωμάτων, γραμμαῖς παραλλήλοις ὑπὸ τῆς φύσεως καταγραφέντα.

And the oysters of the Red Sea are not without the same glamour [as the fish and other fauna], for they are encircled with rings of fiery hue, and to look at them you would say that with the blending of their colours they were copying the rainbow, Nature having painted parallel stripes upon them.

Aelian's initial claim, that these oysters are girdled round with flame-red bands (ζῶναί τε γὰρ περιέρχονται φλογώδεις αὐτά), is intelligible as a description of the mollusc in its shell since the black-lip oyster's outer mantle is fiery red and often clearly visible in the margin between the two valves (Supplementary fig. 3). The shell of the black-lip oyster is not, as suggested by Scholfield's translation, elaborately coloured (its outer shell, when cleaned, is unexceptionally marked with muted black and white stripes and these are not parallel). The inner shell, however, is lined with an iridescent nacre, or mother of pearl, and it is this feature that, together with its pearls, has made this oyster much sought after over many centuries. What Aelian describes as mimicking the rainbow is surely the iridescence of the nacre and in describing the oysters as 'painted by nature with parallel lines' (γραμμαῖς παραλλήλοις ὑπὸ τῆς φύσεως καταγραφέντα) what is referred to is not a colourfully striped shell but rather the way in which the iridescence produces a rainbow effect: it is *the rainbow itself* that is defined by its parallel bands of colour.[48] Not surprisingly, in antiquity these shells were often reused or worked for decorative and utilitarian purposes, as containers, palettes, counters and decorative inlay.[49]

The next passage in our series, 10.20, gives what has long been recognized as 'a graphic description' of a giant clam of the genus *Tridacna*:[50]

Γίνονται δὲ ἄρα ἐν τῇ Ἐρυθρᾷ θαλάττῃ κόγχαι καὶ ἕτεραι, οὐ λεῖαι τὰ ὄστρακα, ἀλλὰ ἔχουσαί τινας ἐντομὰς καὶ κοιλάδας. ὀξεῖαι δὲ αὖται τὰ χείλη εἰσί, καὶ συνιοῦσαι εἰς ἀλλήλας ἐμπίπτουσι, παραλλὰξ ἐντιθεῖσαι τὰς ἐξοχάς, ὡς δοκεῖν δύο πριόνων συνιέντων τοὺς κυνόδοντας εἰς ἀλλήλους συνέρχεσθαι. οὐκοῦν τῶν ἁλιέων ὅτου ἂν νηχομένου λάβωνται καὶ δάκωσιν ὁτιοῦν μέρος, ἀποκόπτουσιν, εἰ καὶ ὀστέον ὑπείη τῷ μέρει τῷ δηχθέντι, καὶ κατὰ ἄρθρου μέντοι δακοῦσαι καὶ τοῦτο ἀπέκοψαν, καὶ εἰκότως· τομώτατον γάρ ἐστι τὸ δῆγμα.

There are also other shellfish in the Red Sea, not with smooth shells but with shells that are ridged and grooved, with sharp lips that when closed fit carefully against one another, locking their protrusions together in a row like the teeth of two saws set one against another. So if these should close on any fishermen swimming by they cut away whatever part they might grip, even if there is bone within the gripped flesh, and if they fall on a joint there too they cleave straight through. It is to be expected since their bite is most cutting.

The prefacing claim that 'there are also other shellfish in the Red Sea' suggests that this passage belongs with 10.13, as does the explicit contrast it makes between the shells of the

[48] See, for example, Dioscorides Pedanius' description of the Illyrian iris as having different coloured flowers parallel to one another (ἄνθη … παράλληλα) like the heavenly rainbow (Ἴριδι τῇ οὐρανίᾳ) (*De materia medica* 1.1.1).

[49] See, for example, the many examples from Myos Hormos (Hamilton-Dyer (2011b) 162–66), Mons Claudianus (Hamilton-Dyer (2001) 290–91) and Mons Porphyrites (Hamilton-Dyer (2007b) 341–54).

[50] Thompson (1947) 118–19, *s.v.* κόγχη.

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giant clam, with their characteristic vertical folds, and the (relatively) smooth-surfaced shells of the previously described pearl oysters (λεῖαι τὰ ὄστρακα). The northern Red Sea is home to three species of the genus *Tridacna* and their exploitation over the *longue durée* is well attested in the archaeological record, which suggests that these giant clams have been harvested for food since the very earliest human occupation of the Red Sea.[51] Like the black-lip pearl oyster, *Tridacna* shells are common for the Roman period at Myos Hormos and also at sites far inland.[52] These clams were exploited as food but the shells were also often worked or reused as decorative vessels or for other utilitarian purposes such as paint pots.[53] In antiquity (as in later periods) *Tridacna* shells from the northern Red Sea were sometimes traded over long distances and appear in a wide range of archaeological contexts. Especially noteworthy are the elaborately carved shells attested in the Near East and across the eastern Mediterranean during the late seventh and early sixth century BC, a production and trade usually ascribed to the Phoenicians (see Supplementary fig. 4).[54]

Next in Wellmann's series is 11.9, a passage describing an island in the Red Sea called Ikaros with a temple and wild animals sacred to Artemis. But this passage belongs rather to a different series of passages interested especially in gods and sacred animals and it is purely coincidental that Ikaros happens to be located in the Indian Ocean: this island, well known to Hellenistic and later to Roman geographers, is located not in the modern Red Sea but rather in the Persian Gulf. It has been identified with Kuwait's Failaka Island, where archaeologists have discovered remains of a Hellenistic Greek settlement that included a number of sanctuaries dedicated to cults of Artemis and other deities.[55]

At 11.21 Aelian seems to pick up using Leonidas directly where he had left off at 10.20, giving another account of a Red Sea mollusc, this time a kind of sea snail:

> Κοχλίας δὲ ἄρα θαλάττιος ὁ ἐν τῇ Ἐρυθρᾷ θαλάττῃ γινόμενος ὡραιότατος ἰδεῖν ἦν καὶ μέγιστος. ἔστι μὲν γὰρ φοῖνιξ τὸ ἔλυτρον, ἔχει δὲ καὶ ἕλικα μεστὴν διηνθισμένην καὶ πεποικιλμένην ὑπὸ τῆς φύσεως. στέφανον ἂν εἴποις ὁρᾶν ἔκ τινος πολυχροίας ἀνθῶν ποικίλως διαπλακέντα πρασίνων τε καὶ χρυσοειδῶν καὶ κινναβαρίνων, ἐναλλὰξ τῶν χρωμάτων κατεσπαρμένων τοῖς διαστήμασιν ἴσοις.
>
> There is in the Red Sea a marine snail that is apparently the loveliest and the largest. Its shell is purple, and it has a full spiral that has been adorned with flowers and finely wrought by nature. You might say it looks like a garland artfully woven from a colourful spectrum of flowers, green and gold and cinnabar, the colours alternating in regular bands.

In a note to his Loeb translation Scholfield identifies this sea snail with an Indian Ocean species, the papal mitre (*Mitra papalis*), but it is recognizably the giant triton (*Charonia tritonis*), which is far and away the largest marine gastropod in the Red Sea. Its shell reaches a length of 60cm and is widely sought after by collectors who prize its size

[51] Richter et al. (2008).

[52] Hamilton-Dyer (2001) 290–92 (Mons Claudianus); Hamilton-Dyer (2007a) 156–58 (Mons Porphyrites); Hamilton-Dyer (2011a) 270–71 (Myos Hormos). *Tridacna* shells are present in Ptolemaic and Roman contexts at Berenike but, like pearl oysters, they are not particularly common; Van Neer and Ervynck (1998).

[53] Mons Claudianus: Hamilton-Dyer (2001) 290; Mons Porphyrites: Hamilton-Dyer (2007b) 156–58; Myos Hormos: Hamilton-Dyer (2011b) 162–66.

[54] Stucky (1974); Fürtwangler (2011).

[55] In what is the earliest extant literary reference to Ikaros, Strabo notes a temple of Apollo as well as an oracle of Artemis Taurobolos (16.3.2), while early Hellenistic epigraphic evidence attests an important cult of Artemis Soteira on the island. For a survey of the archaeological, epigraphic and literary evidence, see Cohen (2013) 140–54; more recently, Hannestad (2019).

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and beauty (Supplementary fig. 5). To understand how closely the shell matches Aelian's description one need only imagine a garland made by threading flowers on a string, but in this case with alternating colours compressed one after another, and the long garland wrapped around itself like the shell's spiral.[56] Like the giant clam and pearl oyster, the giant triton can be found along shallow fringing reefs in the northern Red Sea. Though not nearly as abundant as giant clams or pearl oysters, giant triton shells are present in the faunal record from the Roman period at archaeological sites in the northern Red Sea.[57]

Aelian found 10.13, 10.20 and 11.21 together and there seems little reason to doubt that this was the same source also for a second cluster of passages that begins just after at 11.23–24 and includes 12.24 (omitted from Wellmann's series), 12.25[24] and 12.27[25]. These passages all afford variously detailed but seemingly accurate accounts of different Red Sea species, including a number of colourful reef fish. The first gives an account of the 'citharode fish', a passage long recognized as a remarkable description of a species of butterflyfish and also of the diversity of colouration that occurs within the family Chaetodontidae (11.23, tr. Scholfield):

> Ἐν τῇ Ἐρυθρᾷ θαλάττῃ γίνεται ἰχθῦς πλατὺς τὸ σχῆμα κατὰ τὴν βούγλωττον, ὥς φασι. καὶ φολίδας μὲν οὐ σφόδρα τραχύς ἐστι προσαψαμένῳ, τὴν χρόαν δὲ ὑπόχρυσός ἐστι, μελαίναις τε γραμμαῖς ἐς τὸ οὐραῖον ἀπὸ τῆς κεφαλῆς ἄκρας καταγέγραπται. εἴποι τις ἂν αὐτὰς εἶναι χορδὰς ἐντεταμένας· ἔνθεν τοι καὶ ἰχθῦς αὐτὸς κιθαρῳδὸς κέκληται. τὸ στόμα δὲ αὐτῷ συνίζει καὶ ἔστι μέλαν ἰσχυρῶς, ζώνῃ γε μὴν κροκοειδεῖ κατείληπται· πεποίκιλται δέ οἱ ἡ κορυφὴ διαφόρως τῇ τε χρυσοειδεῖ αὐγῇ καὶ μέντοι καὶ μελαίναις τισὶ περιγραφαῖς. καὶ πτερύγια χρυσοειδῆ ἔχει, μέλαινα δὲ αὐτῷ ἡ οὐρὰ πλὴν τῶν ἄκρων· ταῦτα δὲ λευκὰ ἰσχυρῶς. καὶ ἄλλοι δὲ ᾄδονται κιθαρῳδοὶ στικτοὶ τίκτεσθαι. καί εἰσι πορφυροῖ μὲν τὸ πᾶν σῶμα, γραμμὰς δὲ ἐκ διαστημάτων ἔχοντες χρυσᾶς· ζώνας δ' ἔχουσιν ἐπὶ τῇ κεφαλῇ ἴοις τοῖς ἄνθεσι παραπλησίας, τὴν μὲν πρὸ τῶν ὀφθαλμῶν μέχρι τῶν βραγχίων καθέρπουσαν, τὴν δὲ μετὰ τοὺς ὀφθαλμοὺς ἐς τὸ ἥμισυ τῆς κεφαλῆς προχωροῦσαν, τὴν δὲ περιθέουσαν κατὰ τῆς δέρης ὡς ὅρμον.
>
> In the Red Sea there occurs a flatfish shaped like the sole, so they say. Its scales are not very rough to the touch; its colour is golden, and from head-tip to tail it is marked with black lines. One might describe them as tense strings, which is the reason why the fish itself is called the 'Harper.' Its mouth is compressed and is a deep black and is enclosed in a saffron-coloured ring; its head is variegated, gleaming like gold and with black lines. It has fins like gold, but its tail is black except at the tip and that is the purest white. And other kinds of Harper are said to occur: some are purple all over with golden lines at intervals. They have rings the colour of gilliflowers on their head: one descends from below the eyes down to the gills, another extends from behind the eyes half-way down the head, and another encircles the neck like a necklace.

Georges Cuvier interpreted the passage as describing two fish, which he identified as the melon butterflyfish (*Chaetodon trifasciatus*) and another equally well-known 'butterflyfish' (subsequently reclassified), the emperor angelfish (*Pomacanthus imperator*). The colouration of the melon butterflyfish does not match the precise details given by Aelian for the first, more carefully described species. Thompson, pointing out that there are in fact many more butterflyfish than Cuvier was aware of, concludes that it is possible 'only [to] say that

[56] The shell of the mitre, by contrast, bears little resemblance and the largest specimens reach only a quarter of the size of the giant triton.

[57] Myos Hormos: Hamilton-Dyer (2011a) 283; Mons Claudianus: Hamilton-Dyer (2001) 290–92; Mons Porphyrites: Hamilton-Dyer (2007a) 157.

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Aelian's two species were akin to those with which Cuvier identifies them'.[58] Here again, however, comparison with a more limited range of species present in the northern Red Sea can afford surprisingly certain identification, at least for the first species. The black-tailed butterflyfish (*Chaetodon austriacus*) is among the most commonly encountered Red Sea butterflyfish and, *unlike any other known butterflyfish*, its colouration agrees precisely with the details given by Aelian (Supplementary fig. 6). Its body is golden with black lines, its mouth is black, ringed by yellow (i.e. 'saffron-coloured'), its head is variegated gold with black lines, its pelvic and pectoral fins are gold to match its body but, as suggested by its common English name, its tail is deep black. Perhaps most remarkably, the tip of that tail is not 'the purest white' but rather 'perfectly transparent' (λευκὰ ἰσχυρῶς); here the adjective λευκός is used in the same basic sense by which it might describe crystal clear water.[59]

For the additional 'citharode fish' described in the passage, Cuvier's emperor angelfish remains in my view the likeliest identification, but not if one assumes with Scholfield that the colour description, 'like violet flowers' (ἴοις τοῖς ἄνθεσι παραπλησίας), refers not to common violets (*Viola odorata*) but to 'gilliflowers' or hoary stock (*Matthiola incana*). This flower, which Theophrastus identifies as 'white violet' (ἴον τὸ λευκόν, *Hist. pl.* 6.6.3) shows a range of colouration, making it a poor point of reference in a scientific description. It is far more probable, in my view, that here ἴοις τοῖς ἄνθεσι refers as most often in our sources to the common violet (LSJ, *s.v.*). Assuming what is described is a single kind of fish, reference to the common violet would put these additional markings in the same colour range as the adjective πορφυρός used to describe the fish's body more generally (hence, probably, Scholfield's decision to translate as 'gilliflowers'). As seen already by Cuvier, however, the colouration of the emperor angelfish offers the unique possibility of identification: in addition to the purple colouring of its body, this fish has distinct lines on its head in contrasting shades of purple (Supplementary fig. 7). This proposed identification is not perfect. Missing, for example, is any reference to the emperor angelfish's bright yellow tail, but it matches more closely than any other species present in the Red Sea.

The 'leopard fish' and the Red Sea 'oxyrhynchus' described in 11.24 are likewise varieties of intricately patterned or colourful fish. The leopard fish is described only as having the same colouration and patterning as its terrestrial namesake.[60] The leopard flounder (*Bothus pantherinus*) is common in shallow lagoon and reef habitats of the northern Red Sea (Supplementary fig. 8). Its resemblance in patterning to the land leopard is striking and had Aelian's brief account preserved any description suggesting a flatfish the identification could be considered absolutely certain: it is probably suggestive that this account follows immediately after that of another 'flatfish' (the butterflyfish), since the grouping together of the accounts of shellfish suggests that Aelian's original source may have employed a kind of taxonomic arrangement. The oxyrhynchus is described in slightly greater detail (tr. Scholfield):

> ὁ δὲ ὀξύρυγχος ὁ ἐνταῦθα γινόμενος ἔχει μὲν πρόμηκες τὸ στόμα, τοὺς δὲ ὀφθαλμοὺς χρυσοειδεῖς, τὰ δὲ βλέφαρα αὐτῷ λευκά· τῷ δὲ νώτῳ οἱ σημεῖά τε ἐπέστικται ὠχρά, καὶ πτέρυγες αὐτῷ αἱ μὲν πρῶται μέλαιναι, αἱ δὲ νωτιαῖαι λευκαί· καὶ ἡ οὐρὰ προμήκης τὸ σχῆμα, τὴν δὲ χρόαν πράσινός ἐστι, μέσον δὲ αὐτὴν διείληφε χρυσοειδὴς γραμμή.

[58] Thompson (1947) 115, *s.v.* κιθαρωδός.

[59] See, for example, LSJ, *s.v.* The only other *Chaetodon* that shares most of these features is the Arabian butterflyfish, *Chaetodon melapterus*, but this species lacks the black 'harp strings' on its body.

[60] Πάρδαλις δὲ ἰχθὺς ἐν τῇ Ἐρυθρᾷ φύεται θαλάττῃ, ὡς οἱ θεασάμενοι λέγουσι, καὶ ἔοικε τὴν χρόαν καὶ τὰ στίγματα τὰ περιφερῆ τῇ ὀρείῳ παρδάλει. Thompson (1947) 194 (*s.v.* πάρδαλις) includes the leopard fish in his *Glossary* but does not attempt to identify it.

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> The Oxyrhynchus, which occurs there, has an elongated mouth, eyes like gold, and white eyelids. There are pale markings on its back, and its fins on either side are black, while the dorsal fins are white. Its tail is oblong in shape and its colour is green, and a streak of gold bisects it.

This fish shares its descriptive name with a common Nile fish but the name was also used to describe the sturgeon and perhaps also other Mediterranean species.[61] There are any number of long-nosed fish in the Red Sea but none matching the details as translated by Scholfield. If we imagine the adjective λευκός again describing *transparent* rather than white dorsal fins, there is an obvious candidate, the yellowtail barracuda (*Sphyraena flavicauda*) (Supplementary fig. 9). This species is abundant in the northern Red Sea, where small schools are commonly encountered close to the surface over lagoons and fringing reefs. Its body has pale yellow (ὠχρά, 'ochre-coloured') stripes that are often faint or indistinct but always noticeable is the bright yellow bar running down the middle of its tail (μέσην δὲ αὐτὴν διείληφε χρυσοειδὴς γραμμή). It is fished commercially, as it probably was in antiquity since bones of Sphyraenidae have been found at Myos Hormos and inland at Mons Claudianus.[62] Absence of direct comparison to the Mediterranean barracuda (*Sphyraena sphyraena*, ancient Greek σφύραινα) could be explained by the fact that the yellowtail is a much smaller species and in appearance quite different from not only the Mediterranean species but also other common Red Sea barracudas that would have been identified by Greeks with the familiar *sphuraina*.[63] Alternately, it is probable that at least during the third century BC Greeks in the eastern Mediterranean sometimes used the name *oxurhunchos* in place of the more familiar *sphuraina* and that this usage may have been transplanted to the Red Sea.[64]

After 11.24, the series leaves off for approximately the length of a book, only to resume with a far too brief description of another boldly coloured Red Sea fish at 12.24:

> Ἐν θαλάττῃ τῇ Ἐρυθρᾷ ἰχθὺς γίνεταί φασι, καὶ ὄνομα αὐτῷ ὑγρὸς φοίνιξ, καὶ γραμμὰς ἔχει μελαίνας, καὶ μεταξὺ τούτων κυανέαις σταγόσι κατέστικται.
>
> In the Red Sea they say there is a fish called the 'water phoenix' that has black stripes and between these it is speckled with blue drops.

Thompson suggests the 'water phoenix' is 'probably a Chaetodont', but the description allows no such identification.[65] There are numerous fish in the Red Sea with black stripes and a few that are prominently speckled with blue spots, but the combination of elements is decidedly rare. There are really only two possibilities. The first is that the phoenix is a

[61] See Thompson (1947) 184–85, *s.v.* ὀξύρρυγχος (but omitting any mention of the Red Sea fish).

[62] Myos Hormos: Hamilton-Dyer (2011a) 256; Mons Claudianus Hamilton-Dyer (2001) 288.

[63] Three common Red Sea barracudas (*Sphyraena barracuda*, *Sphyraena qenia*, *Sphyraena jello*) closely resemble the Mediterranean species and can reach 1.5 to nearly 2m in length. The yellowtail barracuda usually does not reach 40cm.

[64] Athenaeus quotes Diphilus of Siphnos for the claim that the κεστρεύς is also called *oxurhunchos* (8.355f: κεστρεὺς δὲ γίνεται μὲν καὶ θαλάσσιος καὶ λιμναῖος καὶ ποτάμιος. οὗτος δέ, φήσι, καλεῖται καὶ ὀξύρρυγχος). The *kestreus*, however, is a grey mullet, whether used generically or of one particular species (probably *Chelon ramada*; see Thompson (1947) 108–10, *s.v.*). There is no apparent reason why it should be called *oxurhunchos*. We know, however, that in Classical Attic usage the barracuda was not usually called *sphuraina* but rather κέστρα (Ath. 7.323b; Thompson (1947) 108, *s.v.*). As shown by Athenaeus, that usage was obscure to later authors and copyists, who may have either corrected κέστρα to κεστρεύς or else associated a claim about the latter with a separate notice about the former. Little is known about Diphilus but he was a contemporary of Lysimachus (Ath. 2.51a) and his work therefore likely dates to the early third century BC; see Wellmann (1903) 1155.

[65] Thompson (1947) 276, *s.v.* φοῖνιξ.

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grouper, in which case it is most probably the bluespotted grouper (*Cephalopholis argus*) or perhaps one of the coral groupers (*Plectropomus pessuliferus* or *Plectropomus areolatus*). In all of these species, the blue spots are often irregular rather than round drops (σταγόνες) and stripes are often indistinct or altogether absent. In every case the spots are distributed over the whole fish (i.e. both between and within any stripes). A second and much likelier possibility is that this fish is not a grouper but the bluespotted wrasse (*Anampses caeruleopunctatus*).[66] This fish is often found in the surf zone along shallow reefs. As suggested by its name, it is covered in bright blue spots.[67] These are perfectly round, but patterned *within* rather than *between* black stripes (Supplementary fig. 10). I suspect that the original source of Aelian's account may have attempted to make the relationship between stripes and spots clear but the different senses of 'between' (μεταξὺ) and 'within' (μετά, ἔνδον, vel sim.) are as easily confused in Greek as in English. It is likely, too, that an explanation for the name has been elided, since *phoinix* is not otherwise attested as a fish name and could, like 'Perseus fish', mask another non-Greek name.[68]

Three additional species are described in the same chapter (12.25[24]). The first of these, called by Aelian the Red Sea σαῦρος or 'horse mackerel', is easily identified:

> Τῷ δὲ σαύρῳ τῷ ἐκεῖθι τὸ μὲν μῆκος τῷ κατὰ τὴν ἡμετέραν γινομένῳ θάλατταν ἴσον ἐστί, ῥάβδοι δὲ αὐτὸν περιέρχονται χρυσῷ προσεικασμέναι ἀπὸ τῶν βραγχίων ἐς τὴν οὐρὰν καθήκουσαι, μέση δὲ αὐτὰς διατέμνει χρυσῆ ἀργύρῳ προσεικασμένη. τὸ στόμα δὲ αὐτῷ κέχηνε, καὶ ἡ κάτω γένυς ἐς τὴν ἄνω νεύειν πέφυκε· πρασίνους δὲ ἔχει τοὺς ὀφθαλμούς, βλέφαρα δὲ αὐτὸν χρυσοειδῆ περιέρχεται.
>
> In length, the horse mackerel there is the same as that occurring in our own sea, but it is patterned with stripes that are gold in appearance and extend from gills to tail, while a silver stripe divides them down the middle.[69] Its mouth gapes open and its lower jaw rises up to meet the upper. It has green eyes and they are circled round with gold lids.

This fish is the Indian or striped mackerel, *Rastrelliger kanagurta*, a commercially valuable coastal pelagic species common in the northern Red Sea (and throughout the Indian Ocean). Its size corresponds precisely with that of the Atlantic horse mackerel (*Trachurus trachurus*) but it is distinguished by its stripes and more especially by the way it swims with its mouth gaping open (Supplementary fig. 11). The meaning of καὶ ἡ κάτω γένυς ἐς τὴν ἄνω νεύειν πέφυκε might at first seem obscure but becomes clear when one observes how when the striped mackerel's mouth gapes open then closes, the lower jaw swings down then back up to meet the upper. An important food fish, it

[66] Remains of groupers (Serranidae) and wrasses (Labridae) are in general only easily identified at the family level, but remains of both families are present at coastal sites in the northern Red Sea as well as inland; see Hamilton-Dyer (2011a) 256–69 (Myos Hormos); Hamilton-Dyer (2007a) 149–50 (Mons Porphyrites); Hamilton-Dyer (2001) 283–89 (Mons Claudianus). Groupers are the most common fish remains in Ptolemaic and early Roman contexts at Berenike; Van Neer and Ervynck (1998) 362.

[67] As with most ancient Greek colour terms, κυάνεος can describe various different shades, but it seems most often to refer to a dark blue or lapis colour (see LSJ, *s.v.*). In his Latin translation of Aelian, Friedrich Jacob (1832) gives *coeruleus*, the same adjective Rüppell used for his descriptive epithet (*caeruleopunctatus*) when choosing a binomial.

[68] Thompson notes an entry in Hesychius for a fish name, φονίς, suggesting it is a doubtful reading that should be corrected to φοῖνιξ and refer to the Red Sea fish. Alternately, Hesychius' entry could preserve a foreign name for the φοῖνιξ, similar to the entry for πέρσος, adopted into Greek as Περσεύς. However, it is not specified that the φονίς is a Red Sea fish (φ 736 Hansen and Cunningham: †φονίς†· ἰχθὺς ποιός).

[69] In the clause μέση δὲ αὐτὰς διατέμνει χρυσῆ ἀργύρῳ προσεικασμένη, García Valdés et al. retain χρυσῆ, rather than, following Hercher, simply deleting it (emendation is also possible, but Jacobs' χύτῳ is not very satisfying). Not much is at stake, but my translation follows Hercher.

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is probable that the striped mackerel was regularly consumed at coastal sites like Myos Hormos.[70]

The Red Sea χάραξ similarly shares its name with a Mediterranean species familiar to the Greeks (12.25[24]):

> ἔστι δὲ καὶ ὁ χάραξ ὁ καλούμενος τῆς αὐτῆς θαλάττης θρέμμα. ἔχει δὲ πτερύγια, καὶ χρυσῷ προσείκασται ὅσα γε ἰδεῖν τὰ παρ' ἑκάτερα, καὶ νωτιαῖα ὅσα καὶ ταῦτα ἔχει χρυσοειδῆ. κατωτέρω δὲ ἄρα εἰσὶ πορφυραῖ ζῶναι τὴν χρόαν, χρυσοειδὲς δὲ καὶ τὸ οὐραῖόν μοι νόει τοῦ αὐτοῦ, πορφυραῖ δὲ ἄρα σκιαὶ τοὺς ὀφθαλμοὺς αὐτῷ μέσους εἰς κάλλος γράφουσιν.
>
> There is also a creature called *charax* belonging to the same sea. It has fins, and its pectoral fins appear like gold, and its dorsal fins are golden too, while its sides below are coloured with purple stripes. Its tail also seems to me to have a golden hue while shades of purple beautifully paint the middle of its eyes.

Thompson notes Cuvier's suggestion that this fish is a species of the family Holocentridae, which includes the Red Sea squirrelfish.[71] Its name, *charax*, was already used by Mediterranean Greeks, probably for one or more species of sea bream (Sparidae), with which squirrelfish share some features, including the spiny dorsal fins that may have suggested the name. The description best matches a squirrelfish very common in the northern Red Sea, the redcoat squirrelfish (*Sargocentron rubrum*) (Supplementary fig. 12).[72] This fish has yellow (or gold) colouring on its fins and tail and its body is prominently marked with reddish-purple stripes (πορφυραῖ ζῶναι). It shares with other squirrelfish a distinctive purple colouration in its beautiful and deeply shadowed eyes.[73]

The description of the last species mentioned in 12.25[24] is unusually concise, but nevertheless likely sufficient to allow identification (tr. Scholfield):

> ὁ δὲ τοξότης ἐν τῇ αὐτῇ θαλάττῃ γινόμενος ἐχίνῳ ὅμοιός ἐστι τὸ εἶδος, κέντρα δὲ ἔχει στερεὰ καὶ μακρά.
>
> The archer occurs in that same sea and is similar to the sea urchin in its appearance, but it has spines that are hard and long.

Thompson follows Renaissance scholars in suggesting that the 'archer' is the porcupinefish (*Diodon hystrix*).[74] That identification is unconvincing (the porcupinefish in no way resembles a sea urchin other than in the fact that it has spines, and these cannot be described as long) but is easily explained by the history of scholarship. Early scholars assumed that what is described must be a fish (rather than another kind of marine animal), and the porcupinefish was already well known to Renaissance naturalists (it was present if less common in the Mediterranean and dried specimens from tropical seas were frequently

[70] At Myos Hormos striped mackerel may be included among the indeterminate Scombridae recorded by Hamilton-Dyer (2011a) 259.

[71] See Thompson (1947) 284–85, *s.v.* χάραξ.

[72] Though common, the redcoat is not commercially important. Faunal evidence suggests that another closely related species, the giant squirrelfish (*Sargocentron spiniferum*), may have been of some commercial value in antiquity: its remains appear in multiple contexts at Myos Hormos (Hamilton-Dyer (2011a) 258) and in Ptolemaic contexts at Berenike (Van Neer and Ervynck (1998) 362). Though otherwise agreeing with the description, its body is shaded red or purple but not striped.

[73] Scholfield's translation ('while purple dots colour beautifully the centre of its eyes') follows Hercher in emending σκιαὶ to στιγμαὶ (based on the error found in V, στεγκιαὶ). Had Hercher observed a squirrelfish eye, the reading σκιαὶ would have been immediately intelligible.

[74] Thompson (1947) 263, *s.v.* τοχότης.

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brought back as souvenirs by sailors). Furthermore, in the very next chapter (following Hercher's numbering), Aelian gives a brief account of Libyan porcupines (12.26[24]):

> Αἱ δέ ὕστριχες αἱ Λιβυκαὶ κεντοῦσί γε τοὺς ἁπτομένους πικρῶς καὶ μέντοι καὶ ὀδύνας ἐνεργάζονται χαλεπὰς τὰ κέντρα. καὶ τεθνεώτων δὲ πονηρὰ τὰ ἐκ τῶν ἀκανθῶν νύγματα ἀπαντᾷ, ὥς φασιν.
>
> Libyan porcupines sharply stab those who touch them and indeed they cause bitter pain. Even when dead their spines cause painful pricks, they say.

Hercher takes this as a discrete account from a distinct source and numbers it accordingly. The editors of the more recent Teubner return to the interpretation that this account belongs with the preceding chapter. In that case, 'Libyan porcupines' refers either to the same fish as the archer or the two were for some reason associated already in Aelian's source. Either would perhaps support the idea that the 'archer' should be identified with the porcupinefish. The problem is that there is no evidence that ὕστριξ was ever used as a descriptive fish name in antiquity and everything about the grammar and syntax (for example, shift from singular to plural, the introduction of another geographical adjective) suggests that Aelian has inserted a distinct account from a different source, prompted no doubt by an association that *only he has made* between the archer's long spines and the terrestrial porcupine. In the opening clause to the next chapter, Aelian signals that he is returning to his source treating Red Sea marine fauna (Ἔστι δὲ ἐν τῇ θαλάττῃ τῇ Ἐρυθρᾷ …, 12.27[25]). Hercher's numbering should be retained, so there remains no reason to identify the archer with the porcupinefish. Nothing in the Greek suggests that the archer is a fish rather than an echinoderm exactly like the sea urchin with which it is directly equated. It is surely relevant that some of the most visually striking species present in the shallow coastal habitats of the northern Red Sea are long-spined sea urchins of the genus *Diadema* (*Diadema paucispinum*, *Diadema setosum*) (Supplementary fig. 13). This identification can be considered certain also for additional reasons (discussed below in section V).

Finally, 12.27[25] offers a detailed account of the Red Sea 'monkey fish' (tr. Scholfield):

> Ἔστι δὲ ἐν θαλάττῃ τῇ Ἐρυθρᾷ καὶ πίθηκος, οὐκ ἰχθῦς, ἀλλὰ σελαχῶδες ζῷον οἱονεὶ ἄλεπον, οὐ μέγα δὲ οὐδὲ τοῦτο. ἔοικέ γε μὴν τῷ χερσαίῳ ὁ θαλάττιος τὴν χρόαν, καὶ τὸ πρόσωπον δὲ πιθηκῶδές οἵ ἐστι. προβέβληται δὲ τοῦ λοιποῦ σώματος ἔλυτρον, οὐκ ἰχθυῶδες, ἀλλὰ ὥς γε τὸ τῆς χελώνης εἶναι. ὑπόσιμος δὲ καὶ οὗτος, οἷα δήπου καὶ ὁ χερσαῖος. τὸ δ' ἄλλο σῶμα πλατὺς κατὰ σχῆμα τὸ τῆς νάρκης, ὡς εἰπεῖν ὄρνιν εἶναι τὰς πτέρυγας ἁπλώσαντα· καὶ νηχόμενός γε ἔοικε πετομένῳ. παραλλάττει δὲ τῷ χερσαίῳ καὶ ταύτῃ. κατάστικτός ἐστι, πυρροὶ δέ εἰσιν οἱ κατὰ τοῦ ἰνίου πλατεῖς, ὡς βράγχια. τὸ δὲ στόμα οὐκ ἐπ' ἄκρῳ τῷ προσώπῳ ἔχει μακρόν, συμφυῶς δὲ τῇ τοῦ χερσαίου πλάσει καὶ κατὰ τοῦτο ὁ ἰχθῦς εἰκασμένος.
>
> There is also a Monkey in the Red Sea; it is not a fish but a cartilaginous creature, and not large at that. And this sea-monkey resembles the land-monkey in colour, and its face is ape-like. But the rest of its body is protected by a sheath, not like a fish but resembling that of a tortoise. It is also somewhat flat-nosed, as the land-monkey is. But the rest of its body is a flat shape like the torpedo, so that one might say that it was a bird with outspread wings; at any rate when swimming it looks like a bird in flight. But it differs from the land-monkey in this way: it is speckled, and the flat parts on the nape of the neck are red, and so are the gills. It has a large mouth at the extremity of its face, and in this respect also the fish bears a natural resemblance to the shape of the land-monkey.

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Despite an abundance of seemingly careful description, the 'monkey fish' is not easily identified. Aelian's account states emphatically that this species is not a bony fish but rather a selachian, but there are no cartilaginous fish in the Red Sea that match these details. Thompson likely points roughly in the right direction by suggesting identification with a species in the genus *Ogcocephalus*, the anglerfish in the family of batfish (Ogcocephalidae).[75] That particular identification is impossible since fish of this genus are not found in the Red Sea (or the Mediterranean) and would have been completely unknown in antiquity. Nevertheless, various features of Aelian's description are suggestive of an anglerfish like *Lophius piscatorius*, a species common in coastal waters of the Mediterranean and well known to ancient fishermen and epicures as βάτραχος or ἁλιεύς (*rana* or *piscatrix* in Latin). Crucially, this fish is miscategorized by Aristotle as a selachian (*Hist. an.* 540b17; *fr.* 194 Gigon, *ap.* Ath. 7.286c; *fr.* 251, *ap.* Ath. 7.330a). As Thompson seems to have suspected, one hypothesis is that the naturalist who observed the monkey fish was influenced by Aristotle's classification of the βάτραχος in placing the monkey fish among the selachians. There are no species of the genus *Lophius* in the Red Sea but there are a number of other more or less closely related taxa that share features with the Mediterranean angler, including species of devilfish and scorpionfish (family Scorpaenidae) and stonefish (Synanceiidae). A number of these are very common in the shallow lagoons and reef habitats of the northern Red Sea. The species that perhaps most closely matches Aelian's account is the tasselled or smallscale scorpionfish (*Scorpaenopsis oxycephala*) (Supplementary fig. 14). To what degree its face resembles a monkey readers may judge for themselves, but this fish is notably smaller than *Lophius piscatorius*, to the naked eye it appears not to have scales (hence 'smallscale') and when startled from the bottom it swims by flapping its large flat pectoral fins in a distinctly birdlike fashion.[76] Its colouration can be described as *katastiktos* and it is distinguished not only by its tassels but also by patches of red colouration, especially around its head and gills.[77]

These interrelated passages share distinctive characteristics suggesting a common source. Especially instructive are linguistic features that will warrant further discussion below, but even casual comparison between accounts like that of the Perseus fish (3.18) and the Red Sea σαῦρος (12.24) reveal a host of shared features. There are paradoxographic elements in some (but not all) of these accounts. Divers lose limbs to giant clams (10.20), pearls are said to form when the oyster beds are struck by lightning (10.13), but the one feature common to all is a core of careful Aristotelian description. Even had we no additional evidence at hand, the simplest explanation would be that Aelian took a whole series of accounts (3.18, 3.28, 10.13, 10.20, 11.21, 11.23–24, 12.24–25[24] and 12.27[25]) from the same section of Leonidas of Byzantium's *Halieutica*. Importantly, only a few chapters after this series ends, Aelian again cites Leonidas as his authority, but this time for a passage on an altogether different topic (12.42[39]). This passage, discussing the use of various kinds of bait, is the basis for Richmond's unlikely hypothesis (similar to Wellmann's) that Aelian relied not on Leonidas directly but rather on some otherwise unknown intermediary, since 'it seems unlikely that Aelian should draw on him for books 1–3, leave him to one side, and return to him in Book 12 for a passage that seems to come from an earlier place in

[75] Thompson (1947) 200, *s.v.* πίθηκος (ὁ θαλάσσιος): 'I take this to be, not improbably, a fanciful description of *Malthe*, a small and quaint relation of the Angler-fish or Fishing-frog (βάτραχος)'. Cuvier's genus name *Malthe* is now obsolete, replaced by *Ogcocephalus*.

[76] One can find online videos of the tasselled scorpionfish swimming in the Red Sea; see, for example, https://www.youtube.com/watch?v=FgmGnoSN114.

[77] The proposed identification with the tasselled scorpionfish is not entirely unproblematic. Aelian's description appears to omit any mention of tassels (these, however, are not always prominent) and it should also be noted that the Greeks already used the name σκόρπαινα for a common Mediterranean species of scorpionfish, *Scorpaena scrofa*; see Thompson (1947) 245–46, *s.v.* The Red Sea fish, however, is distinctly different in appearance.

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the work of Leonidas'.[78] Richmond fails to see that the entire intervening series of passages in books 10, 11 and 12 is also drawn from Leonidas. The most plausible hypothesis is that Aelian set Leonidas aside after 3.28 only to resume where he left off for the Red Sea material in books 10, 11 and 12, then named his source again at 12.42[39] when he moved on to an altogether different section of the work (a section treating, it seems, different methods of fishing and types of gear).[79]

Leonidas dedicated an entire section of his work to the marine fauna of the Red Sea, and there is good reason to believe that the delimitation κόλπω δὲ τῷ Ἀραβίω in the opening clause of 3.18 applied to the whole and that the species described were all marine fauna specifically of the modern Red Sea. Aelian is careful to use a similar specification in 10.13 (ἥπερ οὖν ἐστιν ὁ Ἀράβιος), precisely when he returns to Leonidas as his source. All of the species described in this series are commonly encountered in the shallow coastal waters of the northern Red Sea and a number have more recently established populations in the Mediterranean as Lessepsian migrants (invasive species through the Suez Canal), including the striped mackerel, the yellowtail barracuda, the redcoat squirrelfish, the blacktailed butterflyfish and long-spined sea urchins. At least two species, the masked puffer and the blacktailed butterflyfish, are in fact endemic to the Red Sea and the Gulf of Aden and both are especially common in the northern Red Sea. This evidence, when combined with the undeniable facts of careful autopsy and the soliciting of testimony from local fishermen and divers, suggests a scientific treatise based on research conducted at a site in the northern Red Sea (discussed further below).

That conclusion gives rise in turn to two possibilities: either Leonidas visited the Red Sea himself and conducted such research or he had access to an earlier and apparently otherwise unattested treatise. The first hypothesis seems unlikely: scholars labouring under the illusion that Leonidas belonged to the Hellenistic age might be forgiven for suggesting that his descriptions of fish may have relied on personal observation,[80] but apart from his having recorded a well-known tourist attraction at Poroselene, there is nothing to suggest that Leonidas engaged in that kind of autopsy and the kind of systematic scientific investigation suggested by these accounts would be unparalleled for the second century AD. Even in the absence of better evidence, we should be inclined to assume that Leonidas conformed to the general practice shared by virtually all known post-Hellenistic authors on fish and fishing, described by Richmond as 'content to take their zoological material from earlier authorities, without any aspiration to make original contributions to the lore of the past'.[81] Such generalizations can be misleading and the possibility that Leonidas conducted original zoological research perhaps cannot be ruled out absolutely, but the balance of evidence suggests rather that his Red Sea accounts rely on an earlier, distinctly Peripatetic treatise.

V. The Red Sea Aristotle

Leonidas' source included more than a dozen accounts of Red Sea marine fauna. In contradistinction to how some of these accounts have been treated by scholars, and unlike a good deal of other material that made its way into Aelian's compilation, none of these

[78] Richmond (1973) 30–31.

[79] By this argument Aelian's four citations of Leonidas (not including the epilogue) are not random but prompted in each instance by his consulting a different section of the work. Richmond (1973) 36–37 n.22 offers the reasonable hypothesis that 12.43[40], which offers a typology of fishing methods, also paraphrases Leonidas and both passages likely belonged to a distinct section of the work.

[80] Zucker (2008).

[81] Richmond (1973) 3.

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accounts seems to be invented. Importantly, they seem rather to rely on a programme of research conducted by a knowledgeable expert at a site somewhere in the northern Red Sea. This marine biologist collected information both by interrogating local sources (primarily fishermen, it seems) and through direct autopsy: he observed the masked puffer both inflated and not, and likewise in a state of decay, even perhaps squeezing an oily substance from its lower anal cavity; he held the blacktail butterflyfish in his hand and felt the smooth surface of its skin while recording its intricate colouration; he noted the iridescence of the inside of the pearl oyster's shell but also observed the appearance of its flame-red mantle; he admired the rich shades of purple in a squirrelfish's eye. It is entirely possible that all of the behavioural data he records he owed to fishermen. This is certainly true of his accounts of pearl diving and the (imaginary) risks posed by the giant clam, but some of his descriptions (the way the monkey fish flaps its pectoral fins like a bird as it swims, how the striped mackerel swims with its mouth gaping open) somehow also give a clear impression of autopsy. Here one is tempted to envisage him wading along a shallow lagoon and observing some of the marine life over its sandy bed or around scattered corals: a school of striped mackerel, a startled scorpionfish, butterflyfish in a wide array of colourations.

This picture will perhaps already seem familiar to those interested in ancient science. Over a century ago D'Arcy Thompson sketched the initial outline of what has become a familiar portrait of Aristotle the biologist by suggesting that most of his zoological research 'was carried on, or mainly carried on, in his middle age, between his two periods of residence in Athens … [and] the calm, landlocked lagoon at Pyrrha was one of his favourite hunting-grounds'.[82] That story, which not only gives central place to empirical research conducted on Lesbos in the development of Aristotle's biology but also stresses the importance of his biological theory to the development of his philosophical thought more generally, is told most recently in Armand Marie Leroi's popular (and brilliant) account *The Lagoon: How Aristotle Invented Science* (2014). Although most elements of Thompson's portrait can be disputed,[83] it remains alluring in part because it crystallizes in time and place and personality features of Aristotle's work that have long been admired, especially the fundamental importance of careful observation of nature.[84] As frequently noted, however, in his collection of zoological data Aristotle also often seems to have relied

[82] Thompson (1910) vii. Thompson later stated the thesis more fully in his Herbert lecture treating Aristotle as a biologist ((1913) especially 12–14). This thesis was subsequently adopted and argued more thoroughly by Lee (1948).

[83] Features of Thompson's characterization are clearly anachronistic; the significance of Aristotle's (at most) two-year stay on Lesbos has perhaps been exaggerated; the role of empirical research, too, has been overstated (and his dependence on earlier written accounts as well as second-hand oral reports understated); finally, some of the Lesbos-related material belongs to sections of the *Historia animalium* that most scholars believe are not owed to Aristotle but rather to Theophrastus or other Peripatetic compilers. Nevertheless, thanks primarily to Lee (1948), the notion that during his period of residence on Lesbos Aristotle performed research that was crucial in shaping his biological thought has gained wide acceptance (see, for example, Lloyd (1968) 68–108; Barnes (1996) 8–9). The most often-cited critique remains Solmsen (1978) (although *cf.* in response Lee (1985)) while a number of prominent scholars remain agnostic (see, for example, Natali (2013) 41–42), and others are sceptical that Lee's arguments can be usefully applied to the development of Aristotle's thought or the dating of his work beyond providing a *terminus post quem* for certain of the biological treatises (see, for example, Pellegrin (1986) [1982] 175–76 nn.25–26).

[84] Cuvier, perhaps the first modern biologist (and among the very greatest), is often cited for his intense admiration for Aristotle, and especially his powers of observation; see, for example, Cuvier (1841) 132: 'Tout étonne, tout est prodigieux, tout est colossal dans Aristote. Il ne vit que soixante-deux ans, et il peut fair des milliers d'observations d'une minutie extrème, et dont la critique la plus sévère n'a pu infirmer l'exactitude'. Many scholars have collected similar examples of eminent scientists praising Aristotle's empirical research; see, for example, Lloyd (1987) 53 and, more recently, Leroi (2014) 66–74, with discussion specifically of Cuvier.

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less on autopsy than the testimony of informants whom he considers privileged, including especially, for data about marine fauna, fishermen.[85]

Our Red Sea author's methodology might bear a general resemblance to Aristotle's but this is probably insufficient grounds to argue for direct influence, given the degree to which certain features of early Peripatetic research continued to act as models for 'scientific' discourses in much later periods. Seemingly careful description, claimed or implied autopsy, the citation of privileged informants: well into the Roman period these remain common features even of fantastic or otherwise fictional zoological accounts.[86] Fortunately, we have more direct evidence that our Red Sea marine biologist was intimately familiar with Aristotle's zoological research. The philological evidence is striking. The accounts I have collected share a descriptive vocabulary, and that language is unmistakably Aristotelian. For the most part Aristotle seems to have borrowed his technical terms from everyday usage, but much of this language is systematically redeployed in what is recognizably a kind of technical vocabulary.[87] Numerous words and phrases found in our Red Sea accounts are characteristic of and in some cases otherwise exclusive to Aristotle (and especially his biological treatises). This dependence on Aristotle can be demonstrated by a few concrete examples. I have already suggested that in classifying the 'monkey fish' as a selachian, our Red Sea biologist was guided by Aristotle's classification of the Mediterranean anglerfish. Pliny is likely wrong in suggesting that Aristotle invented out of whole cloth the category 'selachian' (*HN* 9.40), but there is no doubt our author is working within Aristotle's classification scheme and employing the master's vocabulary; unlike the related adjective σελάχιος,[88] which is attested earlier than Aristotle and later employed more widely, the particular adjective Aelian uses, σελαχώδης, is an Aristotelian coinage scarcely attested outside of Aristotle's zoological treatises (and Aelian uses it only here).[89] Perhaps even more striking is another sentence from the same passage: κατάστικτός ἐστι, πυρροὶ δέ εἰσίν οἱ κατὰ τοῦ ἰνίου πλατεῖς, ὡς βράγχια. However we choose to translate κατάστικτός, this usage is Aristotelian (see LSJ, *s.v.* καταστίζω and κατάστικτος), while Aelian's otherwise unusual οἱ πλατεῖς is equivalent to the anatomical term τὸ πλάτος that Aristotle uses of the 'flat part' of flatfish and certain selachians, including specifically the anglerfish.[90] Equally telling is the anatomical term τὸ ἰνίον, describing the occipital bone at the nape of the neck (LSJ, *s.v.*). This usage is not Aelian's (the word occurs nowhere else in his work) and although a simple lexical search on *TLG* will find more than 500 instances, the word can hardly be described as common. It is used already by Homer (*Il.* 5.73 and 14.495) and that usage engenders inevitable comment by the grammarians. Otherwise, the vast preponderance of instances is found in Galen and later medical writers. Galen, of course, owes much of *his* anatomical terminology to Aristotle, including this term for the occipital bone (Arist. *Hist. an.* 491a33–491b1).[91]

[85] Aristotle's dependence on fishermen for much of his data about marine fauna is stressed already by Solmsen (1978).

[86] See, for example, the interesting mix of seemingly scientific and obviously fictional elements in *NA* 15.9.

[87] On Aristotle's technical vocabulary, see, for example, Louis (1956); Lloyd (1983) 152–57.

[88] See Pellegrin (1986) [1982] 9, with 168 n.6, noting ἰχθύσι σελάχεσι in the Hippocratic corpus (*De morbis* 2.50). The *De morbis* 2 is generally thought to predate Aristotle.

[89] A *TLG* search reveals fewer than 50 discrete occurrences of the term, the vast majority of which are owed directly to Aristotle or to later commentaries on the same passages. The few remaining instances are owed to Peripatetic collections like that of Aristophanes of Byzantium and other sources reflecting Aristotle's technical usage (for example, Hsch. Λ 782 Latte, *s.v.* λεώβατος).

[90] See LSJ, *s.v.* πλάτος A.5, and for anglerfish, *Part. an.* 695b15, describing the flat cranial part of its body as τὸ πλάτος αὐτῶν τὸ ἐμπρόσθιον.

[91] On Galen and Aristotle, see Lennox (2001) [1994] 119–23.

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These examples can be multiplied and Aristotelian usages can be identified across the entire series of passages that Aelian borrowed from Leonidas.[92] This technical vocabulary cannot come from Aelian himself but must rather be inherited from his source. Thorsten Fögen concludes from his study of animal nomenclature in the *NA* that as a general rule Aelian *avoids* using Aristotelian technical terminology.[93] I suspect that a more systematic examination would demonstrate that Aelian's use of technical vocabulary is largely a product of his sources, but the end result remains the same since the zoological compendia that Aelian seems to have relied upon most heavily (like that often ascribed to Pamphilus) similarly avoided using Aristotelian technical terminology.

In stark contrast with most Hellenistic and Roman zoological literature, Leonidas' descriptions of Red Sea fauna suggest that the author of his source was a close and careful reader of Aristotle and consciously adopted his technical vocabulary. It has to be admitted that *at least as preserved*, most of these passages show little or no engagement with Aristotle's philosophy of biology and the causes of biological form. For the most part, attention to growth and reproduction is absent, as is any apparent interest in internal organs (there is no evidence at all of dissection). The relatively long account of the Red Sea pearl oyster (*NA* 10.13), however, reveals intimate familiarity with Aristotle's biological theory and suggests that our treatise was not concerned solely with the collection of data but also attempted distinctly Peripatetic scientific explanation. The passage includes at the outset a brief but careful description of the physical appearance of the pearl oyster itself and as such resembles the other accounts of Red Sea fauna. After reporting the folk belief that pearls are formed by lightning, however, it attempts a purely biological explanation: the oyster's shell is its flesh and the pearl is a kind of growth from that flesh analogous to a thorn that forms from the outer layer of some plants (καὶ ἡ μὲν κόγχη τὸ κρέας ἐστίν, ἐπιπέφυκε δὲ ἄρα ὡς σκόλοψ ταῦτα). The analogy with a thorn may have been suggested by a passage in Aristotle that specifically compares oysters to plants (*Gen. an.* 761a30). Unlike a thorn, however, the pearl growth is not plant matter but stone (tr. Scholfield):

> λίθῳ δὲ ἄρα ὁ μαργαρίτης ἔοικε πεπωρωμένῳ, καὶ ἔχειν ἐν ἑαυτῷ καὶ στέγειν ὑγρὸν οὐ πέφυκεν οὐδὲ ὀλίγον.
>
> The pearl, it seems, is like a stone formed by petrifaction, and it is not its nature to contain or to admit a drop of moisture.

Scholfield's translation appears to follow LSJ (*s.v.* πωρόω) in rendering πεπωρωμένῳ as 'formed by petrifaction'. This misses an important nuance. As the same entry in LSJ shows, the verb πωρόω usually refers not to geological but to biological processes, especially the growth of calluses and the formation of stones in the kidneys or bladder. The key passage is again from Aristotle, specifically *Hist. an.* 519b 14–22, a discussion of the bladder that touches on how the stones (λίθοι) that form there somehow arise from dry matter already present (καὶ ξηρὰς συστάσεις, ἐξ ὧν οἱ λίθοι γίγνονται). That passage concludes with the startling and curious claim that 'in some sufferers the stones that form in their bladders seem *indistinguishable from little shells*' (ἐνίοις δ᾽ ἤδη καὶ τοιαῦτα συνέστη ἐν τῇ κύστει ὥστε μηδὲν δοκεῖν διαφέρειν κογχυλίων). Pearls, then, are formed like thorns from the flesh of the inner shell of the plant-like oyster, but these thorns are stony like the shell-stones sometimes formed in the bladder.

[92] Note, for example, *NA* 10.13: γραμμαῖς παραλλήλοις (LSJ, *s.v.* παράλληλος), συσσήπεται (*s.v.* συσσήπω); 10.20: ἐντομὰς (*s.v.* ἐντομή), παραλλὰξ (*s.v.*), κυνόδοντας (*s.v.* κυνόδους); 11.21: ἕλικα (*s.v.* ἕλιξ B.IV), πολυχροίας (*s.v.* πολύχροια), διαστήμασιν ἴσοις (*s.v.* διάστημα), ἐναλλὰξ (*s.v.*); 11.23: χορδὰς ἐντεταμένας (*s.v.* ἐντείνω I.2.b); 12.25[24] κατέστικται (*s.v.* καταστίζω).

[93] Fögen (2009).

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This hypothesis is demonstrated in characteristic Aristotelian fashion by 'natural experiment' relying on inferences from a mass of observational data.[94] Small oysters can produce large pearls, and large oysters small. Some produce none, some a single pearl, some many at a time, in one instance, reportedly, 20. If you open an oyster prematurely, before the generation process is complete, you will only find the flesh (i.e. the mother of pearl). If the pearl is removed and the oyster returned to the sea still alive it can grow another, but if it dies before the pearl is harvested the pearl 'rots away' (συσσήπεται: an important Aristotelian biological term) with the flesh.[95] As is often the case with Aristotle's natural experiments the inferences are weak, the observational data second-hand and sometimes inaccurate.[96] Nevertheless, even if the theory is wrong, and the real mechanism and the true final cause (the oyster has a gland in its mantle that secretes nacre to protect against irritating debris) remain hidden, the language and method of argument are entirely Aristotelian.

Against the other accounts I have ascribed to our Red Sea biologist, this account of the pearl oyster stands out both for its length and for its attention to biological explanation. I would suggest, however, that in its original context it might have been less anomalous. The account includes a short physical description that could easily have been detached from the biological explanation, but Aelian chooses to reproduce this passage at length, not due to any interest in Peripatetic biological theory *per se*, but rather because pearls were an object of intense fascination for Roman imperial audiences. That interest likewise invites rhetorical embellishments, some of which appear awkwardly inserted, whether by Aelian or perhaps already by Leonidas. These include remarks about foreign luxury and a related digression about the value of different pearls and the wealth that accrues to merchants. The way in which a scientific account is framed by these distinctly Roman discourses is echoed by the lengthy discussions of pearls found in both Pliny (*HN* 9.106–24) and Athenaeus (3.93a–94b), the latter of whom states the connection explicitly.[97]

Leonidas' source may have included other similar attempts at biological explanation. Take, for example, the description of the 'archer' in *NA* 12.25[24]. The key phrases ὅμοιός ἐστι τὸ εἶδος, κέντρα δὲ ἔχει στερεὰ καὶ μακρά are translated by Scholfield as generically as possible: the archer 'resembles the sea-urchin in appearance and has hard, long prickles'. As noted in the discussion of its identification above, only an extremely generic interpretation could admit the hypothesis that what is described is not an urchin at all but rather a kind of fish. The language, however, is Aristotelian; the archer is fundamentally similar (ὅμοιος) with respect to its εἶδος, the subsequent δέ emphasizing the

[94] On Aristotle's oft-maligned 'natural experiments' see, for example, Leroi (2014) 361–65.

[95] εὑρεθείη δ' ἂν καὶ ἐν κόγχῃ μεγίστῃ μικρὸς καὶ ἐν μικρᾷ μέγας· καὶ ἡ μὲν οὐδένα ἔχει, ἡ δὲ οὐ πέρα ἑνός, πολλαὶ δὲ καὶ πολλούς· εἰσὶ δὲ οἳ λέγουσι καὶ εἴκοσι προσπεφυκέναι μιᾷ κόγχῃ. καὶ ἡ μὲν κόγχη τὸ κρέας ἐστίν, ἐπιπέφυκε δὲ ἄρα ὡς σκόλοψ ταῦτα. πρὸ καιροῦ δὲ καὶ τῆς ὠδῖνος τῆς ἐντελοῦς εἴπερ οὖν ἀνοίξειε τις τὰς κόγχας, κρέας μὲν ἂν εὕροι, τῆς δὲ θήρας τὸ ἀγώνισμα οὐχ ἕξει … οὐκ ἀγνοῶ δὲ οὐδὲ ἐκεῖνο, ὅτι ἄρα ἐξαιρεθέντων τῶν λίθων τῶνδε ἀφείθησαν αὖθις αἱ κόγχαι, οἱονεὶ λύτρα δοῦσαι τῆς ἑαυτῶν σωτηρίας τὸ σπούδασμα τὸ προειρημένον, εἶτα ὑπανέφυσαν αὖθις αὐτό. ἐὰν δὲ τὸ ζῷον τὸ τρέφον αὐτὸν πρὶν ἢ ἐξαιρεθῆναι τὸν μαργαρίτην ἀποθάνῃ, ὥς που λέγει τις λόγος, τῇ σαρκὶ μέντοι συσσήπεται καὶ ἐκεῖνος καὶ ἀπόλλυται.

[96] In fact, most of this observational data is accurate (as many as 20 pearls have been found in a single oyster), but unlike a thorn on a plant, pearls do not rot away with the flesh of the oyster. As for weak (or faulty) inferences, if oysters form from the flesh like a thorn from that of a plant, should not oysters that are opened prematurely sometimes reveal a pearl in the process of forming from the flesh?

[97] Athenaeus cites the fashion for pearls as justification for including a discussion of Indian Ocean shellfish that is partly indebted to scientific sources like Theophrastus, 3.93a: Περὶ δὲ τῶν κατὰ τὴν Ἰνδικὴν γινομένων ὀστρέων—οὐ γὰρ ἄκαιρον καὶ τούτων μνησθῆναι διὰ τὴν μαργαριτῶν χρῆσιν—Θεόφραστος μὲν ἐν τῷ Περὶ Λίθων γράφει οὕτως.

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key difference that it has spines that are hard and long.[98] The author is surely aware of Aristotle's discussion of an urchin present in the Mediterranean, the long-spine slate pen urchin (*Cidaris cidaris*).[99] The form of his notice seems to directly echo the opening of Aristotle's discussion at *Hist. an.* 530b7–10 (Πρὸς δὲ τούτοις ἄλλο γένος μεγέθει μὲν μικρόν, ἀκάνθας δὲ μεγάλας ἔχει καὶ σκληράς, 'In addition to these [urchins] there is another kind that is small in size, but it has spines that are large and hard'). The slate pen urchin is rarely seen, but Aristotle knew it, reporting that it lives in waters more than 60 fathoms deep and also noting that some people used it as a diuretic. Unlike the Red Sea archer, the Mediterranean urchin's hard spines are thick and blunt rather than arrow-like. More importantly, Aristotle argues in the *De generatione animalium* that its body is small because the cold conditions in the sea's depths cause its nourishment to remain unconcocted, with the residue diverted to its spines, which then grow and, also on account of the cold, harden.[100] How then can the Red Sea urchin, otherwise similar with respect to its *eidos*, have long, hard spines *while living in shallow, warm water*? Surely an Aristotelian biologist would have been interested in how the form of the Red Sea urchin is realized in its environment and this particular observation could be taken to imply an engagement with the master's biological theory. Is it meaningful that whereas Aristotle speaks of different *genē* of urchins, our Red Sea biologist chooses *eidos*?

Unfortunately, any such discussion must remain speculative, although not necessarily because the treatise was fundamentally disinterested in engaging with biological theory but rather, just as probably, because except in very particular circumstances (as with the account of the pearl oyster) the multiple processes of reception (all knowledge of this treatise is at best *third-hand*) have worked to elide scientific argument or explanation. Nevertheless, even accounting for the possibility that the treatise engaged more thoroughly with biological theory, the largely descriptive passages preserved by Aelian suggest a text notably distinct from Aristotle's works of theoretical biology. It bears closest resemblance to the *Historia animalium*, a text James Lennox recently followed much previous scholarship in characterizing as 'a factual investigation preliminary to the search for causal demonstrations'.[101] Allan Gotthelf similarly describes Aristotle's biological investigation as unfolding in three stages corresponding to the collection of data, its organization and finally its explanation; in his view, the purpose of the *Historia animalium* is clearly not simply collecting data (like a notebook) or explanation, but rather the organization of data.[102] Here, too, it has to be conceded that the evidence for the Red Sea Aristotle suggests a treatise governed by principles of organization that are very different from those of a text like the *Historia animalium*. The fragments as preserved suggest a kind of catalogue organized by species. Even if there is also an underlying taxonomic arrangement (accounts of shellfish seem to have been grouped together, and perhaps also species belonging to other categories like flatfish), organization by species is explicitly disavowed by Aristotle in his preface to the *De partibus animalium* (639a12–b5). On the other hand, Aristotle's discussion seems to acknowledge that such an organizational method may have

[98] The adjective ὅμοιος (and compounds) occurs well over 500 times in Aristotle's biological treatises and is the most common way in which he describes fundamental likenesses. On Aristotle's use of the term εἶδος, in particular, see Balme (1962).

[99] Leroi (2014) 142–44; Thompson (1947) 70–73, *s.v.* ἐχῖνος.

[100] *Gen. an.* 783a19–29: σημεῖον δὲ καὶ τὸ ἐπὶ τῶν ποντίων ἐχίνων συμβαῖνον οἷς χρῶνται πρὸς τὰς στραγγουρίας. καὶ γὰρ οὗτοι διὰ τὸ ἐν ψυχρᾷ εἶναι τῇ θαλάττῃ διὰ τὸ βάθος (καθ' ἑξήκοντα γὰρ καὶ ἔτι πλειόνων γίγνονται ὀργυιῶν) αὐτοὶ μὲν μικροί, τὰς δὲ ἀκάνθας μεγάλας ἔχουσι καὶ σκληράς—μεγάλας μὲν διὰ τὸ ἐνταῦθα τὴν τοῦ σώματος τετράφθαι αὔξησιν (ὀλιγόθερμοι γὰρ ὄντες καὶ οὐ πέττοντες τὴν τροφὴν πολὺ περίττωμα ἔχουσιν, αἱ δ' ἄκανθαι καὶ αἱ τρίχες καὶ τὰ τοιαῦτα γίγνονται ἐκ περιττώματος), σκληρὰς δὲ καὶ λελιθωμένας διὰ τὴν ψυχρότητα καὶ τὸν πάγον.

[101] Lennox (2019).

[102] Gotthelf (2012) 383–98.

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been tempting already to his Peripatetic contemporaries, and it is likewise probably no accident that Aristophanes of Byzantium chose to employ the same method of (re)organization for part of his *Epitome*.[103]

It is also worth noting that as a catalogue of Red Sea marine fauna, this treatise seems to have been curiously selective. How many species it treated in addition to the 14 recorded by the passages in the *NA* is impossible to say, but we can be certain that it was far fewer than the well over a thousand species of fish present in the Red Sea (not to mention the hundreds of invertebrates). Careful attention to the accounts we have, however, suggests not a random selection but rather an attempt at a relatively thorough description of a meaningful subset. First, most of the species described are associated with reefs, but there is no reason to believe our Red Sea biologist dived on a fringing reef or attempted to make detailed observations from the surface, since the fragments show no knowledge of the smaller species that populate the Red Sea's teeming reefs.[104] Rather, most of the species described are those that would have been caught regularly by the fishermen who feature in accounts of the Perseus fish, the pearl oyster, the masked puffer and the giant clam. The few species that were likely not commercially valuable, especially the butterflyfish, but also perhaps the masked puffer and the 'monkey fish', are sometimes present in lagoons around patches of rock or coral and are large enough to have been taken periodically as by-catch by fishermen using nets with mesh sizes similar to those attested archaeologically at ancient sites in the northern Red Sea.[105] Put differently, the treatise's field of study can be conceived of as a space shaped in part by geography and ecology but just as importantly by the social and economic contexts so richly attested archaeologically at sites in the northern Red Sea (see below).

This observation is directly related to a second key point, which is that the surviving accounts suggest our author only attempted to describe species recognizably distinct from those present in the Mediterranean. Notably absent are a number of especially abundant and commercially valuable species. For example, there is a species of parrotfish, *Sparisoma cretense*, present in the Mediterranean (especially the eastern Mediterranean). This fish was much sought after in antiquity by epicures and the Greeks called it σκάρος.[106] There are nearly 20 different species of Red Sea parrotfish (family Scaridae) and these were not only abundant and easily targeted but also unusually well-suited for preservation by drying. They were accordingly transported either fresh or dried to sites across the Eastern Desert and even as far as the Nile. This trade is attested archaeologically in the faunal evidence, where species of Scaridae represent far and away the most abundant fish family, comprising well over half of the identified fish remains from Myos Hormos and at inland sites like Mons Claudianus.[107] The trade is also reflected in documentary evidence from Maximianon (now El-Zarqah) and Krokodilo (El-Muwayh), where ostraka attest demand specifically for parrotfish, called by the same name as the Mediterranean species,

[103] Lennox (2001) [1994]: 116–17; Hellmann (2006).

[104] These include scores of different anthiases: hawkfish, dottybacks, gobies, blennies, clingfish and dragonets.

[105] Hamilton-Dyer (2011a) 257 notes the absence of the butterflyfish (and other 'decorative' reef fish) in the faunal remains at Myos Hormos. For the archaeological evidence for fishing nets at Myos Hormos, see Thomas (2010) 146–48 and (2011) 211–14; at Berenike, Veldmeijer (2004); at the late Roman fort at Abu Sha'ar, Wendrich and Van Neer (1994).

[106] Thompson (1947) 238–41, *s.v.*

[107] Parrotfish represent over half of the overall fish remains and approximately 60 per cent of the identified remains from Myos Hormos (Hamilton-Dyer (2011a) 260, table 20.13) and approximately 34 per cent of the total or half of the identified remains at Mons Claudianus (Hamilton-Dyer (2001) 286, table 9.23). Parrotfish are less abundant at Berenike, representing less than 30 per cent of the identified fish remains from the Ptolemaic period, and less than 20 per cent of those from the early Roman period, but even in the latter case they remain third in overall abundance after groupers and emperors (Van Neer and Ervynck (1998) 362; Hamilton-Dyer (2011a) 268, table 20.21).

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σκάρος (*O.Max.* 793; *O.Krok.* 1; *O.Krok.* 63). The ostraka similarly attest demand for τρίγλη (*O.Max.* 707; *O.Max.* 869; *O.Max.* 1300) and κεστρεῖς (*O.Krok.* 1; *O.Krok.* 63). The first is the common Greek name for Mediterranean red mullet or goatfish (*Mullus barbatus* and *Mullus surmuletus*) but here is no doubt used to refer to the Red Sea goatfish, in the same family (Mullidae), of which there are roughly a dozen species.[108] The second is one of the more common Greek names for the Mediterranean grey mullet and is here likely used for Red Sea species in the same family (Mugilidae).[109] The ostraka otherwise only refer generically to fish, whether fresh or preserved,[110] but we can presume that Greeks used familiar Mediterranean names for a number of other commercially important Red Sea taxa, including various groupers (Serranidae), wrasses (Labridae) and sea breams (Sparidae).[111] We might also presume that the author of our treatise made no attempt to describe most of these species, on the assumption that they were either the same as their Mediterranean namesakes or so closely similar as not to warrant scientific description. That decision seems to rely, in turn, on the assumption that there already existed an established body of knowledge concerning the marine fauna of the eastern Mediterranean. The same understanding informs our author's descriptions of the shapes and sizes of Red Sea fauna, which frequently rely on explicit comparison. The author is a student of Aristotle and even if his treatise did little to advance the master's biological theory, in collecting and organizing new empirical data about the natural world, his project is recognizably Peripatetic.

VI. Context and identity

Our marine biologist must have been a Peripatetic who visited the Red Sea, but further identification is likely impossible. Other than Aristotle and Theophrastus, only a single Peripatetic is reliably attested as having conducted research related to marine biology. Although better known to scholars for his interests in eastern thought and possibly as the author of a famous inscription discovered at Ai-Khanoum,[112] Clearchus of Soli also wrote a *Περὶ τῶν ἐνύδρων* (*On Aquatic Animals*) and perhaps a monograph specifically treating the electric ray (the *Περὶ νάρκης*).[113] Only four fragments can confidently be assigned

[108] Thompson (1947) 264–68, *s.v.* τρίγλη.

[109] Thompson (1947) 108–10, *s.v.* κεστρεύς.

[110] Thomas (2011) 216 conveniently collects the evidence; see also the discussion in Marzano (2013) 277–80. Additionally, shellfish is attested by the generic name βάλανος, and reference to γλαυκισκάριον νηρόν (*O.Max.* 639) may denote an additional kind of fish, but as suggested already by Leguilloux (2003) 573, it more probably refers to parrotfish, or a particular kind of parrotfish. Fresh fish is generally referred to as ὀψάριον/ὀψάρια (*O.Krok.* 1 and 63; *O.Max.* 1138 and 1463; *O.Claud.* 241 and 529 (ὀψαρίδια)), salted or dried as τεμάχιον or ταρίχιον (*O.Claud.* 233 and 1264; *O.Max.* 876).

[111] Nevertheless, we might expect him to have described a number of commercially important species belonging to families not present in the Mediterranean. Among the missing taxa, the emperors (Lethrinidae) would have been the most important commercially, comprising approximately 23 per cent of the identified fish remains from Ptolemaic and early Roman Berenike; Van Neer and Ervynck (1998) 362. On the other hand, these are not particularly visually arresting. Perhaps harder to explain would be the absence of accounts of visually striking surgeonfish and unicornfish (Acanthuridae) which, while not overly abundant, are nevertheless present in the ancient faunal remains even at inland sites: Hamilton-Dyer (2001) 283–89 (Mons Claudianus); Hamilton-Dyer (2007a) 150 (Mons Porphyrites).

[112] Robert (1968) remains the most compelling argument for identifying the author of the Ai-Khanoum inscription with Clearchus of Soli. The majority of scholars now seem to accept that identification but decisive evidence is lacking. For a general introduction to Clearchus, see more recently Schneider (1994); Tsitsiridis (2013) 1–20. The forthcoming RUSCH volume on Clearchus (Mayhew and Mirhady 2022) is eagerly anticipated.

[113] The *Περὶ νάρκης* is only known from a single mention in Athenaeus (*fr.* 105 Wehrli, *ap.* Ath. 7.314c), who points the reader to that work for a fuller discussion of the cause of the electric ray's characteristic shock. It is possible that Clearchus' discussion of the electric ray belonged originally to the *Περὶ τῶν ἐνύδρων*.

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to the *Περὶ τῶν ἐνύδρων* (*frs* 101–04 Wehrli). Three of these are known from Athenaeus, who likely found them attributed to Clearchus in one or more of his lexicographic or encyclopaedic sources. At least one such source seems to have included direct excerpts from the *Περὶ τῶν ἐνύδρων*, including a passage concerning the mysterious ἐξώκοιτος or Adonis fish, an account that Athenaeus claims to reproduce verbatim (*fr.* 101 Wehrli, *ap.* Ath. 8.332b–e). Based especially on this account, the *Περὶ τῶν ἐνύδρων* has been characterized as paradoxographic.[114] In fact, we ought to be extremely wary about making generalizations based on so few fragments, especially when their reception is so clearly guided by selective pressures.[115] The scientific content of Clearchus' work is a question that I hope to revisit in greater detail in a different venue. That Clearchus may have conducted original zoological research is suggested especially by the *Περὶ νάρκης*. Although only known from a single mention in the *Deipnosophistae* (*fr.* 105 Wehrli, *ap.* Ath. 7.314c), in that passage Athenaeus points the reader to Clearchus for what he promises is a very full discussion of *the cause* (τὴν αἰτίαν) of the electric ray's characteristic shock.[116]

As has long been recognized, Clearchus is likely one of the sources utilized by Leonidas.[117] Furthermore, Clearchus' account of the Adonis fish shows some noteworthy similarities in its organization and descriptive language with our accounts of Red Sea fauna, which would seem to invite the hypothesis that they are indebted to none other than Clearchus himself. That possibility should probably be ruled out. There is no evidence that Clearchus' travels ever touched on the Red Sea or that his work on marine biology included accounts of Red Sea fish. Although relatively few fragments can be ascribed with absolute certainty to Clearchus' biological works, they were mined by later encyclopaedic and catalogue sources, none of which shows any knowledge of the Red Sea material collected by Leonidas. The absence of Clearchus' name from among those known to Pliny as having written about the Red Sea might also require explanation. The most compelling argument against attributing this material to Clearchus of Soli is based on historical context, however. Clearchus attended Aristotle's lectures in the Lyceum (*frs* 6, 8, 37, 64, 91, 97 and 108 Wehrli), which would place his birth no later than the mid-fourth century. Louis Robert argued that he must have already been at least 50 years of age if he visited Ai-Khanoum *ca.* 290 (and indeed older if the date of the city's founding is pushed down, as has been suggested based on archaeological evidence). It is theoretically possible that Clearchus could have visited the northern Red Sea already during the reign of Ptolemy I and made a study of those species in the region best known to its fishermen, but the

[114] See, for example, Wehrli (1969) 81–83 and (1983) 550; Althoff (1999) 157–59; Hellmann (2006) 330.

[115] As noted specifically of Clearchus by Hellmann (2006) 330 n.5.

[116] Clearchus' arguments were apparently so full that Athenaeus claims he is unable to remember them (ἅπερ μακρότερα ὄντα ἐπιλέλησμαι)! I also suspect that Clearchus is ultimately the source (perhaps by way of Leonidas) for Oppian's account at *Halieutica* 2.56–85 (see also 3.149–55), which identifies the lateral organs responsible for the shock. Clearchus' treatise sought to investigate the same phenomenon that piqued the interest of, among others, Plato (*Meno* 80a), Aristotle (*Hist. an.* 620b19–29) and Theophrastus (*fr.* 369 Fortenbaugh, *ap.* Ath. 314b). For additional ancient sources, see Thompson (1947) 169–71, *s.v.* νάρκη.

[117] The fragments of the *Περὶ τῶν ἐνύδρων* show that material taken from Clearchus was included in a kind of catalogue or list source compiled probably in the Roman period and reflected in book 1 of Oppian's *Halieutica* and likewise book 9 of Aelian's *NA*, including accounts of the Adonis fish (*Halieutica* 1.155–67 and *NA* 9.36) and the octopus (*Halieutica* 1.308–311 and Ael. *NA* 9.45; *cf.* Clearchus *fr.* 102 Wehrli, *ap.* Ath. 7.317b–c). For an extremely thorough discussion of all of this material, see Benedetti (2005) especially 16–18 and 31–47. As seen already by Wellmann (1895) and Richmond (1973) 42–43, 46, 73–74, a number of other passages in the same books of Oppian and Aelian may well include material from Clearchus via the same list or catalogue source. While Wellmann identified that intermediary source as Leonidas, and Richmond continues to suspect the same, there is no reason that this need be the case (Benedetti (2005) tellingly leaves the question open). Leonidas is more probably the source for Oppian's account of the octopus' affection for the olive tree at *Halieutica* 4.264–307. In that case Leonidas may have drawn directly on a relatively elaborate account in Clearchus' *Περὶ τῶν ἐνύδρων*.

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context attested by the fragments suggests rather an author at work *at least* a full generation later than Clearchus.

Importantly, when visiting the Red Sea the author of our treatise found a population that included both Greek and non-Greek speakers, including the indigenous fishermen whom he seems to have described as Arabs (Ἄραβες, *NA* 3.28). That term is one of the exonyms, together with the terms Fish Eaters (Ἰχθυοφάγοι) and Trogodytes (Τρωγοδύται), that Greeks of the Hellenistic and later periods used to describe indigenous populations in the Eastern Desert and along the neighbouring coast of the Red Sea.[118] In the Roman period two ostraca from Mons Claudianus mention 'Arabs' in the context of the fish trade (*O.Claud.* inv. 529 and 830), suggesting that local populations often acted as intermediaries in the trade with indigenous fishermen on the coast.[119] In his second-century AD synthesis of geographical knowledge, Ptolemy hints at the ways in which these exonyms could overlap when he describes the entire northwestern coast of the Red Sea as populated by Arab-Egyptian Fish Eaters (Ἀραβαιγύπτιοι ἰχθυοφάγοι, *Geog*. 4.5.27). It is also worth noting that our marine biologist is likely not the primary source of Agatharchides' famous description of the Fish Eaters (*frs* 30–50), a portrait driven by a kind of historical anthropology carefully constructed so as to obscure the degree to which indigenous fishing communities in the region were sometimes integrated into the economics of Ptolemaic settlement and trade.[120] At two of the primary Ptolemaic settlements in the northern Red Sea, Berenike and Myos Hormos, fishermen provided vital provisions for local populations while surplus catches were preserved and transported to inland sites. The richest archaeological and documentary data is Roman, when growth in Indian Ocean trade and the opening of numerous quarries in the Eastern Desert led to increased demand for fresh and preserved fish. But during the Ptolemaic period fishing economies were already well developed at Berenike (and certainly at Myos Hormos too, even if the Ptolemaic settlement is yet to be defined archaeologically),[121] with fishermen employing technologies far more varied and advanced than suggested by Agatharchides' portrait of Stone Age Fish Eaters lacking all *technē*. Although their equipment is richly attested archaeologically, fishermen themselves are largely invisible.[122] Nevertheless, and this is the key conclusion for our purposes, these Arab-Egyptian Fish Eaters served markets that translated the names of their catches into Greek for Greek-speaking consumers, and also, apparently, for the occasional student of Aristotle.

Virtually all of the evidence for Greek settlement in the Red Sea dates to the reign of Ptolemy II or later. The hieroglyphic Pithom Stele attests that the canal connecting the Red Sea to the Nile was dredged only in year 16 of Ptolemy II's reign (*CGC* 22183; 270/69 BC).[123] The same text records the foundation a few years later of Arsinoe, the primary Ptolemaic settlement on the Gulf of Suez, and immediately thereafter a large-scale expedition in

[118] For a recent introduction to the Ptolemaic (and later) documentary evidence and its problems, see de Jong (2017). The documentary evidence generally supports claims about the 'importance of the Arab presence in the eastern deserts of Egypt in Ptolemaic times' (Burstein (1989) 69 n.2), with the caveat that terms like 'Arabs' (Ἄραβες) and 'Arabic' (Ἀραβικός) need not refer to Arab peoples, but rather a local Bedouin population.

[119] Cuvigny (2003) 346.

[120] Thomas (2010) 158; Thomas (2011) 218. On Agatharchides' historical anthropology, see especially Ameling (2008).

[121] For a review of the textual evidence for Myos Hormos and its identification with Quseir al-Qadim, see Cohen (2006) 332–38; for evidence suggesting that remains of the Ptolemaic settlement may lie in still-unexcavated levels below the current water table, see Peacock and Blue (2006a) 174 with Peacock and Blue (2011) 345.

[122] One Roman-period ostrakon from Myos Hormos does attest a certain Pakubis, identified as an *ichthuophagos*, in possession of a *schedia*, a 'raft', or perhaps more probably a modest fishing vessel (*O.Myos* 512; another *schedia* is explicitly linked to the fish trade in *O.Max.* 175).

[123] On this canal project and its relationship to Red Sea settlement and trade, see Sidebotham (2011) 179–82. For an English translation of the Pithom Stele, see Mueller (2006) 192–99.

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264 BC to found a settlement far to the south at Ptolemais Theron on the coast of Sudan.[124] It is likely that during the same period or shortly thereafter Ptolemy II founded both Berenike and Myos Hormos and established the routes and infrastructure required to connect these ports to the Nile.[125] Arsinoe would have been the most easily accessible Red Sea settlement for an Alexandrian scholar, but environmental change and the absence of ancient faunal evidence comparable to that from Berenike and Myos Hormos makes it difficult to evaluate whether the research attested by our treatise could have been conducted there (I suspect it is possible). By contrast, the documentary and archaeological evidence from Roman Myos Hormos and the inland sites connected to it by trade allows for a more detailed portrait of cultural and economic activity related to fishing and trade. The site itself offered a protected sandy lagoon immediately adjacent to a shallow fringing reef facing deep pelagic waters. All of the species described in our treatise could have been observed or harvested within a stone's throw of the harbour.[126]

Regardless of where exactly the research was conducted, it followed Ptolemaic settlement and trade in the Red Sea and therefore cannot have taken place earlier than roughly the middle of the third century BC. Its author may have belonged to the golden age of Ptolemaic science and exploration in the third and early second century BC. A few authors are attested as having written works during that period treating subjects related to the Ptolemaic exploration of the Red Sea. Unfortunately, little is known about these authors and although they were clearly important sources for Agatharchides, very few fragments can be attributed to specific authors or works, and none of these suggests a Peripatetic zoological treatise.[127] An admiral of Ptolemy II, Pythagoras, wrote an *On the Erythraean Sea* and he is known to have been interested in exotic African animals, but nothing suggests he was a Peripatetic or that his work treated marine fauna.[128] Under Ptolemy III, a certain Simmias is known to have led an expedition down the African coast of the Red Sea and his account included ethnographic description of the Fish Eaters, but otherwise virtually nothing is known about him or his work.[129] More intriguing is a certain Philon, whom Pliny, relying on Juba, describes as a praefect of Ptolemy II and the first to develop the mining of peridot on Zabargad Island some 80km southeast of Berenike (*HN* 37.108; *FGrH* 275 F 75). It is generally assumed that this is the same Philon who wrote an account of a voyage to Aithiopia (Strabo 2.1.20). He seems to have had scientific interests since he is known to have made careful astronomical observations that were later used by Eratosthenes.[130] I have already suggested, based on an entry in Hesychius, that the Red Sea Aristotle's work may have been known to Alexandrian lexicographers. It is therefore

[124] Cohen (2006) 308–09 (*s.v.* Arsinoe/Kleopatris), 327–28 (*s.v.* Klysma) and 341–43 (*s.v.* Ptolemais Theron).

[125] Cohen (2006) 332–38 (*s.v.* Myos Hormos) and 320–25 (*s.v.* Berenike Trogodytika). Epigraphic evidence attests that some Ptolemaic infrastructure along the route to Berenike was in place no later than 257 and some mining operations in the Eastern Desert were active already under Ptolemy I. For a concise discussion of Ptolemaic roads and stations in the Eastern Desert, see Sidebotham (2011) 28–31. As noted by Cohen, the foundation of Myos Hormos is widely dated by scholars to the reign of Ptolemy II but explicit evidence is lacking. Peacock follows earlier scholarship in proposing that Myos Hormos and Berenike were both founded *ca.* 275, but without offering any real evidence (Peacock and Blue (2006b) 3). Mueller (2006) 151–52 suggests that Ptolemy II initiated all of his Red Sea exploration and settlement between 270 and 260.

[126] For the environment at Myos Hormos, see Blue (2006); Thomas (2010) 144. At Berenike, by contrast, the seasonal flow of freshwater and sediment from adjacent *wadi*s prevented the formation of coral reefs in the immediate vicinity of the harbour; see Sidebotham (2011) 9–11.

[127] Burstein (1989) 32–33.

[128] Mann (2011) (= *FGrH* 2214). Pythagoras seems to have been the source for many later accounts of African animals, suggesting a general zoological curiosity, but his scientific interests are difficult to gauge. Moreover, it is clear that his literary account was relatively widely available and used by a number of later authors who seem to have had no knowledge of the material I have ascribed to the Red Sea Aristotle.

[129] Orth (2013) (= *FGrH* 2218).

[130] See *FGrH* 670, and, more usefully, Burstein's commentary at *BNJ* 670.

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worth noting that another entry in Hesychius identifies the term στρωματεύς as the name of a Red Sea fish.[131] Athenaeus seems to have had access to a related source: in the context of discussing a kind of sea bream (the σάλπη), he notes that there is a comparable fish in the Red Sea called the στρωματεύς (the 'quilt' or 'bedspread') on account of the fact that its body is covered with gold stripes.[132] Here Athenaeus cites a certain Philon, more specifically an otherwise unattested work whose title is usually translated as *On Metals* (ἐν τῷ Μεταλλικῷ), but which should perhaps be *On Mining*. These references may all be to the same Philon, a Ptolemaic official with a range of scientific interests, but even if we accept that hypothesis, the evidence is far too slim to allow us to identify him with the Red Sea Aristotle.[133] Philon's career does, however, emphasize the crucial role of Ptolemy II Philadelphus and Ptolemy III Euergetes in encouraging the production of scientific knowledge about the Red Sea, and it is possible that the Red Sea Aristotle's research belongs to the same milieu. One could prove that hypothesis by showing that the Red Sea Aristotle's research was known to Agatharchides of Cnidus, who, probably during the middle decades of the second century BC, synthesized a wide range of early Ptolemaic sources in his *On the Erythraean Sea*. The evidence is, I would argue, strongly suggestive, even if ultimately inconclusive.

VII. Agatharchides of Cnidus and the humphead wrasse

Unlike his other works, which are attested only by titles or by relatively few fragments, Agatharchides' *On the Erythraean Sea* was of considerable interest to subsequent authors, chiefly because of the wealth of geographical and ethnographic detail contained in its fifth book.[134] After an extended description of the Ptolemaic gold mines (*frs* 22–29 Burstein), detailed ethnographies of the Fish Eaters, Trogodytes and other populations (*frs* 30–67), and accounts of notable wild animals and their capture (*frs* 68–80), Agatharchides turned his attention to a geographical survey of the Red Sea, implying that his account would rely on privileged Ptolemaic sources (Diod. Sic. 3.38.1, tr. Burstein, *fr.* 81, slightly modified):[135]

> Διευκρινηκότες δ' ἀρκούντως τὰ περὶ τὴν Αἰθιοπίαν καὶ Τρωγλοδυτικὴν καὶ τὴν ταύταις συνάπτουσαν μέχρι τῆς διὰ καῦμα ἀοικήτου, πρὸς δὲ ταύταις περὶ τῆς παραλίας τῆς παρὰ τὴν Ἐρυθρὰν θάλατταν καὶ τὸ Ἀτλαντικὸν πέλαγος τὸ πρὸς μεσημβρίαν κεκλιμένον, περὶ τοῦ καταλελειμμένου μέρους, λέγω δὲ τοῦ Ἀραβίου

[131] T Σ 2055 Hansen: στρωματεύς· ἰχθῦς ποιὸς ἐν τῇ ἐρυθρᾷ θαλάσσῃ.

[132] Ath. 7.322a: γίνεται δ' ὅμοιος ἰχθὺς ἐν τῇ Ἐρυθρᾷ θαλάσσῃ ὁ καλούμενος στρωματεύς, ῥάβδους ἔχων δι' ὅλου τοῦ σώματος τεταμένας χρυσιζούσας, ὡς ἱστορεῖ φίλων ἐν τῷ Μεταλλικῷ. The σαλπή, the goldine or Salema porgy (*Sarpa salpa*), is noteworthy primarily for its gold stripes; see Thompson (1947) 224–25, *s.v.* σαλπή.

[133] As far as I can tell, no one has proposed identifying the author of *On Metals* with the Ptolemaic official; for the former, see Laqueur (1941) and the latter, Kroll (1938); Burstein (2008). Wellmann (1935) 436 n.2, however, does propose identifying the Philon mentioned by Athenaeus with Philon of Heraclea, third-century BC author of a paradoxographic collection, a suggestion that is interesting both because of the close relationships between early paradoxographic collections and Peripatetic science and because the Philon who was a Ptolemaic praefect is known to have had paradoxographic interests.

[134] For a discussion of the evidence for Agatharchides' career, see Burstein (1989) 12–18, with earlier bibliography. For the testimonia and fragments of works other than *On the Erythraean Sea* (which Jacoby excludes as geographical rather than historical), see *FGrH* 86, more usefully with Burstein's discussion and commentary at *BNJ* 86. Like Burstein, I am unconvinced by the arguments of Marcotte (2001) and Ameling (2008) that the five books of *On the Erythraean Sea* belonged to a single work of world history in 49 books organized ethnographically.

[135] On the organization of book 5, see Burstein (1989) 26, with additional discussion in the commentary. References to specific fragment numbers of Agatharchides follow Burstein (1989). Because Burstein's edition does not include texts but only translations, I also give references to the original texts. The question of Agatharchides' sources deserves careful reappraisal, but see Woelk (1966) 255–66; Burstein (1989) 32–33.

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> κόλπου, ποιησόμεθα τὴν ἀναγραφήν, τὰ μὲν ἐκ τῶν ἐν Ἀλεξανδρείᾳ βασιλικῶν ὑπομνημάτων ἐξειληφότες, τὰ δὲ παρὰ τῶν αὐτοπτῶν πεπυσμένοι.
>
> Now that we have examined in sufficient detail Aithiopia and Trogodytice and the adjacent territory as far as the region that is uninhabited because of the heat and, in addition, the coast of the Erythraean Sea and the Atlantic Ocean which faces southward, we shall describe the remaining portion, I mean the Arabian Gulf, on the basis of information that we have obtained from the royal *hypomnemata* at Alexandria and that we have learned from eyewitnesses.

Here Diodorus is closely paraphrasing Agatharchides, who employs the same designation, Arabian Gulf, to make the same geographic distinction in his introductory material in book 1 (*fr.* 2a = Phot. *Bibl.* Cod. 250.2).[136] The passage is especially important in asserting that what follows is based on *hupomnēmata*, apparently first-hand accounts of Ptolemaic officials, or abstracts derived from such accounts, archived at Alexandria, or to other sources described enigmatically as 'eyewitnesses'. Although this reference to 'eyewitnesses' has been taken by some scholars to suggest either that Agatharchides directly interviewed witnesses or that he had access to documentary sources apart from the *hupomnēmata*, it has been demonstrated convincingly that Agatharchides here refers to previously published accounts by authors who, unlike himself, could claim to rely on autopsy. In what is probably an epilogue, Agatharchides notes that he was forced to break off his work since disturbances in Egypt made it no longer possible to examine the *hupomnēmata* (*fr.* 112 = Phot. *Bibl.* Cod. 250.110), suggesting that he was still at work on his project in 145 or even perhaps as late as 132 BC.[137] If Agatharchides has any documentary value, it ultimately derives from his sources, most of which, including the published accounts, seem to be indebted to the third-century BC Ptolemaic exploration and exploitation of the Red Sea, especially under Ptolemy II and Ptolemy III.[138]

Agatharchides includes some limited information related to marine fauna and fishing in his ethnographic accounts of the Fish Eaters and related populations like the Turtle Eaters, but evidence suggesting he made use of the same zoological treatise known to Leonidas is provided rather by a kind of appendix to the geographical survey of the Red Sea that concluded book 5. This appendix collected *thaumasia*, specifically unusual natural phenomena peculiar to the Arabian Gulf and especially, it seems, to the coastal fringing reefs that provided a livelihood for its fishermen (*frs* 107–11).[139] Although other sections of book 5 are known from additional sources, especially Diodorus but also, probably via Artemidorus, Strabo and Pliny, we owe our knowledge of this appendix almost exclusively to Photius. It included not only a discussion of tides but also of *paradoxa* like the reef 'plants' that gently bend under the action of waves but mysteriously stiffen when removed from the water, apparently describing tropical sea fans, the protein cores of which quickly harden when exposed to the air.[140] Agatharchides also collected at least one account that is explicitly ichthyological (Phot. *Bibl.* Cod. 250.109, *fr.* 111, tr. Burstein):

[136] Diodorus' dependence on Agatharchides in this passage is demonstrated by Peremans (1967), whose arguments are endorsed by Burstein (1989) 30. For Photius' *Bibliotheca*, references are to Henry's Budé edition.

[137] Burstein (1989) 15–17.

[138] On Agatharchides' documentary and other sources, see Burstein (1989) 29–33, with additional bibliography. On present evidence, none of his sources can be shown to be later than Eratosthenes, and a number can be shown to date to the reign of Ptolemy II.

[139] This appendix follows geographic surveys of the African and Arabian coasts of the Red Sea (*frs* 81–86 and 87–98, respectively) and an addendum on the Sabaeans of Yemen (*frs* 99–106).

[140] Phot. *Bibl.* Cod. 250.108 (tr. Burstein, *fr.* 110): Ἔστι δέ τι φυόμενον αὐτόθι κατὰ βάθος ἐν ταῖς ῥαχίαις, μελαίνῃ σχοίνῳ παραπλήσιον, ὅ φασιν οἱ ἐκεῖσε κατοικοῦντες Ἴσιδος εἶναι τρίχωμα, μυθώδει πλάσματι πίστιν εὐήθη περιτιθέναι ζητοῦντες. Συμβέβηκε δ' αὐτῷ τυπτομένῳ μὲν ὑπὸ τοῦ κύματος κάμπτεσθαι πολλαχῶς, ἁπαλῆς οὔσης τῆς ὅλης περιοχῆς καὶ τοῖς ἄλλοις παραπλησίας φυτοῖς· ἂν δέ τις ἀποκόψας εἰς τὸν ὕπαιθρον

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> Ὅτι καὶ ἄλλοι μὲν πολλοί, φησιν, ἰχθύες περὶ τοὺς προειρημένους τίκτονται τόπους, παρηλλαγμένην ἔχοντες τὴν φύσιν, γίνεται δέ τις ἰχθὺς ὑπερβαλλόντως μέλας, ἀνδρὸς ἔχων μέγεθος, ὃν καλοῦσιν Αἰθίοπα διὰ τὸ καὶ τοῦ προσώπου σιμὸν ἔχειν τὸν τύπον. Τοῦτον κατ' ἀρχὰς μὲν οἱ θηρεύσαντες διὰ τὴν ὁμοιότητα οὔτε πωλεῖν ἠξίουν οὔτε καταναλίσκειν, τοῦ δὲ χρόνου προϊόντος ἀμφότερα πράττοντες οὐδὲν ἁμαρτάνουσι.
>
> Many other kinds of fish, he says, are also born in the previously mentioned places which are unusual in character. There is, however, one kind of fish that is extremely black in colour, about the size of a man, and is called 'Aithiopian' because its face is snubbed in shape. At first, those who catch it think it is not right to either sell or eat it because of this resemblance, but with the passage of time they do both without compunction.

Thompson proposes no identification for the 'Aithiopian' fish in his *Glossary*, perhaps because he considered the account fanciful, an opinion of Agatharchides' work more generally that was not uncommon in the late 19th and early 20th century despite a growing body of comparative evidence offering close analogies for some (but certainly not all) of his descriptions.[141] That evidence was first synthesized by Dieter Woelk in his commentary to the fragments and forms the primary basis for Stanley Burstein's conclusions about Agatharchides' 'basic accuracy'.[142] Woelk saw that Agatharchides' account of the Aithiopian fish likely describes a real fish and consulted an ichthyologist at the Naturmuseum Senckenberg, Wolfgang Klausewitz, who suggested what seems far and away the most probable identification, the humphead wrasse, *Cheilinus undulatus* (Supplementary fig. 15).[143] The flesh of this strangely anthropomorphic species (it has commonly been referred to in the past by other suggestive names including 'Napoleon fish' and 'Maori wrasse') is widely considered a delicacy and in recent decades it has been fished almost to extinction across much of its former range. It is still present, however, along many shallow Red Sea reefs and, where protected from overfishing, it reaches sizes of more than 2m in length and close to 200kg in weight. Its greenish blue to dark brown colouration fades to black when the fish is removed from the water and dies.[144] The faunal evidence confirms that wrasses were commercially important to ancient fishermen in the northern Red Sea.[145]

If we take Agatharchides at his word that he knows of many different fish that inhabit the reefs of the Arabian Gulf, we are required to presume either that he had access to a distinct source or that his and Leonidas' accounts are more directly related. The evidence

ἀναφήνῃ τόπον, σιδήρου παραχρῆμα γίνεται τὸ διῃρημένον σκληρότερον, 'There is a kind of plant that grows underwater there in the tidal zone. It resembles black rush, and the natives call it "Isis' tresses" in an attempt to add a naive credibility to a mythical tale. When this plant is struck by a wave, it bends every-which-way since its whole stalk is soft and like that of other plants. But if a person cuts off a piece and exposes it to the air, the separate piece immediately becomes harder than iron'. As noted by Burstein (1989) 172 n.3, there are a number of species of gorgonian (class Anthazoa) that occur in the Red Sea that could match Agatharchides' description. Pliny, *HN* 13.142, attributes to Juba a similar account of the Hair of Isis, *Isidis crinis*. In his commentary to this fragment of Juba (*BNJ* 275 F 67), Roller suggests that '[t]he passage has a folkloristic quality and probably comes from oral sources'. Here, as elsewhere, Juba is likely relying directly on Agatharchides.

[141] Thompson (1947) 4, *s.v.* Αἰθίοψ: 'A great, black, useless fish of the Red Sea'. Given the context, Thompson's characterization of the fish as 'useless', which finds no support in the text (and is directly contradicted by the fish's apparent economic value), is discomfiting.

[142] Woelk (1966); Burstein (1989) 36.

[143] Woelk (1966) 252–53.

[144] Woelk offers as a second possibility identification with a species in the family Lutjanidae (snappers), but the largest Red Sea snappers reach only about a metre in length and otherwise do not conform to Agatharchides' description.

[145] For the remains of Labridae at Red Sea and inland sites, see, for example, Hamilton-Dyer (2001) 283–89 (Mons Claudianus); Hamilton-Dyer (2007a) 149–50 (Mons Porphyrites); Hamilton-Dyer (2011a) 256–69 (Myos Hormos).

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is hardly conclusive but some of it points in the latter direction. Agatharchides is motivated to give accounts of the 'Aithiopian' fish and sea fans not because of scientific interest but rather because he believes his readers are especially interested in unusual or paradoxical phenomena. In this respect he is not unlike Aelian, and like the accounts Aelian found in Leonidas, Agatharchides' material seems to derive from a source that relied on a similar mix of first-hand observation and the testimony of privileged informants, specifically identified as fishermen. Furthermore, a relationship between Leonidas and material known from Agatharchides has already been proposed, albeit on different grounds. Keydell suggests that a passage of Agatharchides excerpted by Photius (*Bibl.* Cod. 250.47 = *fr.* 47a) and paraphrased by Diodorus (3.21.1–5 = *fr.* 47b) is the ultimate source for accounts of the hunting of sea turtles given by Pliny (*HN* 9.35–36) and Oppian (*Halieutica* 5.392–409). Oppian, Keydell suggests, likely relied on Leonidas as an intermediary, since the poet's account immediately precedes accounts related to the dolphin that more certainly are taken from Leonidas (*Halieutica* 5.416–519). Keydell stops short of suggesting that Leonidas' other Red Sea accounts relied directly on Agatharchides, but that possibility obviously deserves consideration, even if the evidence suggests that it should be rejected, for at least two reasons.

First, the passage quoted by Photius at *Bibl.* Cod. 250.109 (*fr.* 111) is best taken as implying that although Agatharchides *knows* of descriptions of many different Red Sea reef fish, he chose to give *only* an account of the 'Aithiopian' fish. In that case, it is not likely that this section of Agatharchides' work included additional accounts of Red Sea fish. Secondly, Leonidas' account of the Perseus fish, specifically, cannot have been taken from Agatharchides. Its aetiological claim that the fish is called after Perseus, whom both Greek and Arabs recognize as the son of Zeus, is incompatible with the views Agatharchides expresses in his programmatic account of the etymology of the Red Sea, which seems to have opened book 1 (*frs* 2–8 = Phot. *Bibl.* Cod. 250.2–8). Agatharchides is not only sceptical of historical claims based on myths, including specifically those that would connect Perseus to the Red Sea, he also explicitly rejects linguistic claims like that made about the name of the Perseus fish (*fr.* 6). Leonidas' source for the Perseus fish seems rather to be one of those authors *against whom* Agatharchides ingeniously constructs his own authority by weaving together logical critique of previous hypotheses (*frs* 2–4, 6), the privileged testimony of an alleged Persian acquaintance named Boxus (*fr.* 5) and a sustained attack on the use of myth as evidence (*frs* 7–8). If there is a relationship between the material Aelian found in Leonidas and the work of Agatharchides, it must rather be due to the fact that Leonidas and Agatharchides made independent use of the same source.

One of the attractions of this hypothesis is that it invites more nuanced readings of both sets of fragments. For example, as excerpted by Photius, Agatharchides' description of the humphead wrasse (*fr.* 111) suggests it was taken together with the immediately preceding account describing a seemingly marvellous marine 'plant' (sea fans are not plants but sessile colonial cnidarians). The sea fan is introduced as growing αὐτόθι κατὰ βάθος ἐν ταῖς ῥαχίαις (Phot. *Bibl.* Cod. 250.108 = *fr.* 110), which Burstein translates as 'underwater there in the tidal zone'. Following LSJ, ῥαχία is attested as referring to the '*flood-tide*' (*s.v.* I.1), but the word as commonly used refers to a '*rocky shore* or *beach*' (II), and would seem here to describe the Red Sea's characteristic fringing reefs. It is this same habitat that the opening clauses of the very next fragment refer to as 'those places previously described', home to many different kinds of fish, including the humphead wrasse (Ὅτι καὶ ἄλλοι μὲν πολλοί, φησιν, ἰχθύες περὶ τοὺς προειρημένους τίκτονται τόπους, παρηλλαγμένην ἔχοντες τὴν φύσιν, Phot. *Bibl.* Cod. 250.109 = *fr.* 111). It is this particular Red Sea environment that has notably altered the nature of its fauna, παρηλλαγμένην ἔχοντες τὴν φύσιν.

If it seems likely that Agatharchides found descriptions of the sea fan and humphead wrasse in the same source, then it is perhaps worth considering too the immediately preceding account in which Agatharchides acknowledges the existence of vigorous

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philosophical debate about the causes of tides but carefully sidesteps engaging directly either with evidence for the complexity of tides in the Red Sea or with existing causal theories (Phot. *Bibl.* Cod. 250.107 = *fr.* 109).[146] Tidal motion posed a famous and ultimately irresolvable problem for Aristotelian physics and in this regard Agatharchides' reticence about engaging with his immediate source or the larger problem is easily understood.[147] Agatharchides may have encountered this discussion of Red Sea tides in a different source, such as Eratosthenes, but we might also imagine the possibility that the material on marine fauna was framed by a broader introduction to the Red Sea's marine environment or perhaps the chapters on marine biology only comprised one section within a larger Peripatetic work treating the natural history of the Arabian Gulf.[148]

Whatever its overall scope, on balance it seems more probable than not that Leonidas and Agatharchides made independent use of the same Peripatetic treatise. A few difficulties would remain, but they are far from disqualifying.[149] As with the passages in Aelian, some of the vocabulary in Agatharchides' account of the humphead wrasse finds close parallels in Aristotle,[150] but here the question of usage is complicated by the fact that Agatharchides himself seems to have been a Peripatetic.[151] On the other hand, given Agatharchides' philosophical orientation together with the fact that in researching his work on the Red Sea he conducted an exhaustive search for textual sources, it seems probable that he would have made use of a Peripatetic zoological text had it already existed. The point is not trivial. Perhaps the most attractive feature of the hypothesis that Agatharchides made use of the Red Sea Aristotle is that it allows us to situate the latter's zoological research in the context of early Ptolemaic exploration and the associated production of scientific knowledge. If one concludes to the contrary that Agatharchides'

[146] The Red Sea exhibits wide variability in tidal ranges, which are highest at both the northern and southern extremes and minimal at its central latitudes. Burstein's translation of ἐν ταῖς ῥαχίαις in *fr.* 110 is likely influenced by the discussion of tides in the preceding passage but I note that the term ῥαχία is not used to refer to tides in *fr.* 109 (Phot. *Bibl.* Cod. 250.107).

[147] Agatharchides may even have been aware of the arguments famously advanced by a likely contemporary, Seleucus of Seleucia. As reported primarily by Strabo, relying on Posidonius, Seleucus presented detailed arguments for a lunar theory of tides, and these seem to have been based on a combination of astronomical data and detailed tidal observations made in the Red Sea or the Persian Gulf. See Strabo 1.1.6, 3.5.9, 16.1.6; Neugebauer (1975) 3.610–11 and 697–98.

[148] A few passages in Aelian hint in the same direction, for example, the introduction to *NA* 10.13 compares the bright colouration and complex patterning of the Red Sea's marine life to the animal fauna of Arabia more generally.

[149] The fact that the material Aelian borrowed from Leonidas does not include accounts of sea fans or the humphead wrasse might seem to require explanation (the likeliest is that Agatharchides' account was so well known that Leonidas deliberately avoided reproducing that material even though he found it in their common source). Perhaps more problematic is that this hypothesis requires us to assume that Agatharchides had to hand an account of the Red Sea pearl oyster that he chose not to reproduce (the absence of any mention of oysters in Agatharchides has been one of the primary reasons for the assumption that no such industry existed in the Red Sea in antiquity), but this may not be as problematic as it seems: the documentary evidence discussed above suggests that by the first century AD, Red Sea pearl production was under the direct supervision of Roman officials, yet there is no trace of this in the scientific description that Leonidas found in the Red Sea Aristotle. Agatharchides may have chosen not to include a strictly scientific account of pearls simply because they were not yet of intense cultural interest to his audience and their production not yet subject to direct Ptolemaic control. On the development of the Roman fascination with pearls, see Schneider (2018).

[150] See, for example, σιμὸν (LSJ *s.v.* σιμός), διὰ τὴν ὁμοιότητα (*s.v.* ὁμοιότης), καταναλίσκειν (*s.v.* καταναλίσκω 2), παρηλλαγμένην (*s.v.* παραλλάσσω).

[151] Strabo 14.2.5 describes Agatharchides as a Peripatetic and a historian (εἴτ' Ἀγαθαρχίδης, ὁ ἐκ τῶν Περιπάτων, ἀνὴρ συγγραφεύς), but our best evidence for his biography is owed to a single source, Phot. *Bibl.* Cod. 213 (= *FGrH* 86 T 2), which describes him as a 'secretary and reader' (ὑπογραφέα δὲ καὶ ἀναγνώστην) to the well-known Ptolemaic statesman Heraclides Lembus, who is often described as a member of the Peripatetic school and at the very least seems to have had Peripatetic interests (for example, he was the author of a collection of excerpts from the Aristotelian *Politeiai*); see Bloch (1940); Burstein (1989) 14–15.

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accounts of sea fans and the humphead wrasse are unrelated, then the Red Sea Aristotle's treatise becomes even more enigmatic, its production likely postdating the supposed disappearance of scientific zoology not only by a few decades or generations but perhaps by centuries.

VIII. Conclusion: Ptolemaic imperialism and Hellenistic scientific zoology

Sometime after the establishment of permanent Ptolemaic settlements on the coast of the Red Sea, a Peripatetic with zoological interests and careful knowledge of Aristotle's biological works visited one of those settlements and collected information about some of the region's unique marine fauna. His method of collecting data, careful observation and description combined with interrogation of privileged informants, was modelled on Aristotle, and although our Red Sea zoologist chose to organize that material in a fashion that the master had explicitly rejected, it is nevertheless likely that by cataloguing his information and organizing it by species he adhered to a practice that was already well established among Peripatetic researchers. Even if a host of questions about the author and the nature of his research project remain unanswered, it would seem apparent that the portrait I have sketched is at odds with key features of an orthodox narrative in the history of science, according to which interest in scientific ichthyology disappeared in the early Hellenistic period, despite the example of Aristotle. Albert Günther's remarks in his *An Introduction to the Study of Fishes* might fairly be regarded as typical:

> That one man should have discovered so many truths … is less surprising than the fact that for about eighteen centuries a science which seemed to offer particular attractions to men gifted with power of observation, was no farther advanced. Yet this is the case. Aristotle's disciples, as well as his successors, remained satisfied to be his copiers or commentators, and to collect fabulous stories or vague notions.[152]

This fate was not particular to ichthyology, but shared by the larger field of biology, and historians of science have long puzzled over the apparent fact that whereas other sciences continued to develop in the Hellenistic period, 'zoology and botany, the sciences Aristotle and Theophrastus had made their own, declined in the Lyceum without developing elsewhere'.[153]

Texts of zoological interest continued to be generated outside of the Lyceum throughout the Hellenistic and later periods but scholars are often quick to note that these are of a very different character and predominantly the product of Alexandrian literary scholarship. So, for example, Robert Sharples:

> In zoology the Peripatetics wrote as natural scientists, the Alexandrian scholars as literary scholars and encyclopaedists, at one remove from their scientific subject-matter and concerned especially with the explaining of classical literary texts.[154]

These literary and encyclopaedic texts, the argument holds, displaced in ancient book collections the rigorous systematic investigations that had been authored by the early Peripatetics, ensuring that biology would enjoy no later renaissance.[155]

[152] Günther (1880) 3.

[153] Sharples (1999) 151. On these points surveys of the history of the Lyceum generally all agree, differing only in their accounts of the causes of decline; see, for example, with a survey of earlier scholarship, Lynch (1972) 135–62; more recently, Sharples (1995) 32–37; Lennox 2001 [1994].

[154] Sharples (1999) 148.

[155] Sharples (2010) xiv; Sharples (1995) 32–37. For the production of zoological collections: Kullmann (1998); Hellmann (2006); White (2015).

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In what remains perhaps the fullest recent treatment of *why* subsequent generations ignored 'a richly articulated zoological research program', Lennox rejects two of the usual hypotheses, that Hellenistic scholars had no access to Aristotle's zoological texts after the death of Theophrastus or that there was a dearth of sufficiently talented individuals to carry on that research, but he nevertheless concludes that scientific zoology did in fact disappear in the early third century.[156] Strato of Lampsacus' well-documented interest in natural philosophy may have included biological investigation, but there is little evidence he engaged in or promoted original zoological research of any kind, and it is assumed that even if he did, any such research would have ceased at the Lyceum after his death (no later than 268).[157]

Such discussions sometimes acknowledge that they rely on problematic data sets: much of the Hellenistic science that we happen to know about exists only as titles or in scant fragments; a great deal more is entirely lost.[158] Papyrological finds are tremendously important but relatively rare; more often, our fragments are the product of later reception, which inevitably deforms. Nevertheless, in the absence of any positive evidence it has been difficult to argue that scientific zoological investigation continued after Theophrastus (and perhaps Strato) or that it may even have had a place among the scientific research carried out especially at Alexandria during the third century BC.

It will be apparent that the material I have attributed to the Red Sea Aristotle is somehow related to these larger issues. I concede that this fragmentary evidence is insufficient to suggest that later Hellenistic Peripatetics meaningfully advanced Aristotle's biological theory, but it is evident that the Red Sea Aristotle wrote not as a literary or encyclopaedic scholar but as a natural scientist, and his research cannot be made to fit the neat dichotomy suggested by scholars like Sharples. He is too late to have belonged to the earliest generations of Peripatetics and if he studied at Athens it was more likely under the direction of Strato or a later scholar. His evidence suggests at the very least that Aristotle's biological works remained accessible, despite ancient and modern accounts alleging their disappearance after the death of Theophrastus.[159] It also suggests that for at least some Peripatetics, Aristotle's zoology was conceived of as an ongoing project to which it was possible to make meaningful contributions even if his theoretical biology was considered more or less complete.

If zoological research continued to be pursued in the Lyceum, we might imagine the Red Sea Aristotle having been dispatched to the Red Sea to collect specific information in the same way that later traditions imagined Aristotle directing his students, most famously Alexander the Great, in the gathering of data from distant locales.[160] There is little evidence, however, that the Lyceum was ever involved in directing these types of far-flung research project and it seems more probable that our Peripatetic zoologist belonged to a different research community. Although Rudolph Pfeiffer argued forcefully that the

[156] Lennox (2001) [1994].

[157] For the fate of biological research in the Lyceum after Strato, see Sharples (2006); Hellmann (2006). While it is clear that Strato engaged with Aristotle's philosophy of biology, there is precious little evidence that he engaged in any original zoological research; see the evidence collected by Sharples (2011) 133–77, nos 55–81.

[158] Lennox (2001) [1994] 114 notes Pliny's 'truly frightening list of vanished texts' and likewise 'the admittedly fragmentary evidence for the Lyceum'.

[159] The ancient evidence for the fate of Aristotle's library (especially Strabo 13.1.54 and Plut. *Sull.* 26) has generated a tremendous amount of discussion and a wide range of competing theories; see, for example, Düring (1957) 412–25; Gottschalk (1972) 335–42; Moraux (1973); Gottschalk (1987) 1083–88; Blum (1991) 53–64; Barnes (1997); Johnstone (2014) 375–80. For a recent and masterful overview, see Hatzimichali (2013) 11–27, with additional discussion in Hatzimichali (2016). On the continued availability of Aristotle's works in the Hellenistic period, see, for example, Barnes (1997) 12–16, and for the biological works, specifically, Sharples (1999) 151–52.

[160] Plin. *HN* 8.44

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Alexandrian literary scholars described as Peripatetics are not in any real sense Aristotelian (and often in fact anti-Aristotelian), scholars have increasingly returned to the view that early Alexandrian scholarship is marked by strong Peripatetic influences.[161] Many such discussions continue to emphasize ancient accounts connecting the early Ptolemies and the Museum to Aristotle and the Lyceum, although very nearly all of these sources are late and most should be treated as apocryphal.[162] Much better evidence, however, is afforded by careful studies of the fragments of Alexandrian scholarship showing its close affiliations with Peripatetic theory and method.[163] This research suggests that there existed under the early Ptolemies a thriving community of Peripatetics at Alexandria and it is likely that these Aristotelians included scholars engaged in original scientific research.

Admittedly, there is no direct evidence in the fragments of the Red Sea Aristotle to suggest any connection to the Ptolemies or the Museum, but the hypothesis does at least allow for a plausible answer to the question of *why* such a treatise may have been written. The interest of the early Ptolemies in exploration, exotic fauna and the systematic collection of knowledge is reasonably well attested, and patronage could perhaps suggest a context for the production of a scientific treatise documenting the marine fauna of their recently settled eastern sea.[164] That hypothesis could be made to fit literary and historical approaches stressing the relationships between knowledge and power.[165] Those perspectives already inform general accounts of the development of Hellenistic science and more particularly discussions of the relationships between the Library and Museum at Alexandria and Ptolemaic royal ideology.[166] From this point of view it is worth noting that this proposed context for the Red Sea Aristotle's research would find a curious echo in another work of Egyptian cultural production, albeit in a very different medium and from a much earlier historical period. The Eighteenth Dynasty funerary temple of Hatshepsut at Deir el-Bahari is famous especially for its painted reliefs depicting an expedition to the land of Punt. A noteworthy feature of these reliefs is that depicted beneath the ships in a kind of frieze are marine fauna. As noted long ago by Flinders Petrie, these renderings

[161] Pfeiffer (1968) 87–88, 137–38 and 150–51; Lynch (1972) 136–37. Pfeiffer's arguments led to much subsequent debate; for a synopsis, see Richardson (1994); more recently, Montana (2015) 76–82.

[162] There exists a wide range of scholarly opinion about ancient traditions linking the Lyceum and the Museum, but for opposing views see already, for example, Fraser (1972) 1.312–16 and Lynch (1972) 121–23. See, more recently, Canfora (1993) 11–16 and (1999); Montana (2015) 76–82. Ancient accounts related to the founding and organization of the Library seem to be especially unreliable; on which, see Bagnall (2002) 348–56 and Johnstone (2014) 362–68.

[163] See, for example, Schironi (2009); Cadoni (2010); Montanari (2012) and various contributions to Montanari et al. (2015).

[164] Ptolemy II's scientific interests and perhaps more especially his interest in collecting exotic fauna are well known. Key sources include Agatharchides *fr.* 1 (Phot. *Bibl.* Cod. 250.1) and *fr.* 80b (Diod. Sic. 3.36.3–37.9) and Callixeinus of Rhodes (*FGrH* 627 F2). Although late and not necessarily reliable, Strabo describes the Ptolemies as keen explorers and Ptolemy II, in particular, as 'a lover of inquiry' (φιλιστορῶν), driven by his physical disabilities to constantly seek new distractions. The ancient evidence for Philadelphus' interest in exotic animals is collected already by Hubbell (1935).

[165] In terms of theoretical orientation, the work of Foucault and Said is especially influential; see, for example, Foucault (1969) and (1980); Said (1993); Vasunia (2003). Applications to antiquity are too numerous to survey here, but see, for example, Swain (1996); König and Whitmarsh (2007) (with a useful introduction).

[166] For general accounts of the development of ancient science during the Hellenistic period see, for example, Luce (1988); Rihll (1999); and, focusing on the central role of the Library at Alexandria, Jacob (1998). For the political significance of the Museum and Library, see, for example, Erskine (1995), where, however, much emphasis is placed on the connection between Aristotle and Alexander the Great and on the Lyceum as a model for the Museum. Very nearly all of the sources are late and unreliable, and this is especially true of accounts related to the Library, on which see especially Bagnall (2002) 348–56 and Johnstone (2014) 362–68. For the Museum, too, far less is known about its organization and activities in the third century than is often assumed; see, for example, Fraser (1972) 1.312–19.

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are 'no mere fancy' but products of 'close observation',[167] and many can be safely identified as species found in the Indian Ocean and the Red Sea.[168]

Even if we grant that Ptolemaic patronage may have played a role in the production of a treatise on the marine fauna of the Red Sea, and I believe that the theory is attractive, that relationship surely can offer only a partial explanation. In discussing the apparent disinterest of later generations in early Peripatetic zoological science, Lennox offers what is essentially a sociological explanation: despite the availability of Aristotle's texts, talented researchers were not convinced that the lesser animals were 'legitimate objects of theoretical, demonstrative science' and instead preferred to 'turn their talents to less messy, more noble subjects'.[169] It is worth emphasizing, however, that this is no more than an argument from absence, whereas the evidence for an *orthodox* view of biology as ignoble is generally no earlier than Cicero, and if *Roman* attitudes about what pursuits should be considered noble are strongly articulated, that fact alone would seem to suggest the possibility of a different explanation. The evidence I have presented here suggests to the contrary that in the Hellenistic period Aristotle's famous protreptic at the end of the first book of the *De partibus animalium* (644b23–645a24) for students to treat even the humblest of animals as worthy objects of enquiry, did not always fall on deaf ears and that in the third and probably into the second century BC Peripatetics continued to pursue scientific zoological investigation alongside researchers interested in medicine, human anatomy, astronomy, geography and other more 'noble' subjects. The selective processes of Roman reception ensured that nearly all such research disappeared almost without a trace. Leonidas of Byzantium, however, not only got hold of what must have been an exceedingly rare text by the second century AD, he also decided, for reasons that are not entirely clear, to devote a section of his remarkable *Halieutica* to the marine fauna of the Red Sea. I suspect that additional evidence for Hellenistic zoological science could be found similarly hiding in plain sight, in all likelihood disguised, like Agatharchides' accounts of the sea fan and the 'Aithiopian fish', as paradoxography.

Supplementary material. For supplementary material accompanying this paper visit https://doi.org/10.1017/S0075426922000106

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[167] Petrie (1896) 83.

[168] Danelius and Steinitz (1967), with earlier bibliography.

[169] Lennox (2001) [1994] 123.

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