

A new species of *Pecten* (Mollusca: Bivalvia: Pectinidae) from northern Western Australia

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Abstract

Pecten dijkstrai n. sp. is described from several localities in northern Western Australia. It represents a new, rare example of a tropical member of the genus *Pecten*. The new species most closely resembles *P. excavatus* Anton, 1838, previously reported from southern Japan to Indonesia, differing in its smaller size, greater length (antero-posterior dimension), more numerous, lower radial costae and slightly paler colouration.

Key words: *Pecten dijkstrai* n. sp., taxonomy

Introduction

The scallop genus *Pecten* (Müller, 1776) is distributed throughout temperate and sub-tropical seas (Rombouts 1991; Raines and Poppe 2006) and has figured prominently in the scientific literature, partly as a result of its commercial importance, and partly due to its prominence in morphological and molecular genetic investigations into the origins and speciation of the family Pectinidae, as well as of the genus itself (Kilburn and Dijkstra 1995; Wilding *et al.* 1999; Rios *et al.* 2002; Saavedra and Peña 2004). However, there is still some debate about the actual number of extant *Pecten* species, as Raines and Poppe (2006) recognised 14 species worldwide, whereas Dijkstra (1998) recognised 15.

Although more than 100 species of scallops (family Pectinidae) have been recorded from Australian waters (Lamprell and Whitehead 1992; Lamprell and Healy 1998; Dijkstra and Beu pers. comm.), *Pecten fumatus* (Reeve 1852) is the only widely accepted Australian *Pecten* species. Therefore, the discovery of a new species of *Pecten* predominantly from the tropical north-western coast of Western Australia is an interesting development, not only from the perspective of the Australian Pectinidae, but also in relation to the genus *Pecten* and its wider phylogeography.

Materials and methods

In 2004 five intact, paired specimens of a species of *Pecten* were collected by SCUBA diving in approximately 40 m of water from two sites in Western Australia. The sites were approximately 200 km apart, off Gnarlaloo (approximately 130 km north of Carnarvon), and in Exmouth Gulf. Three specimens were collected off Gnarlaloo and two from Exmouth Gulf. The specimens were found around limestone reefs on a coral sand substrate and were considered to be unlike any previously described from WA, or from Australian waters, and warranted further investigation.

The specimens were qualitatively compared with other

Pecten spp. from the region, followed by statistical comparison of multiple shell parameters with the most similar species using discriminant function analysis and *post-hoc* testing in SPSS (version 12.0).

Subsequently, a specimen was deposited at the Australian Museum, Sydney (AMS) (accession number C.462684) and designated as the holotype, with additional material maintained in the AMS, GW and PD. Further material was made known to us by Henk Dijkstra (Amsterdam, Netherlands) and Alan Beu (Lower Hutt, New Zealand; pers. comm. September 2011).

Abbreviations

AMS—Australian Museum, Sydney; AP—antero-posterior dimension (shell length); DV—dorso-ventral dimension (shell height); GW—G. Wilson collection, Albany, Australia; HM—H. Morrison collection, Kingsley, Australia; PD—P. Duncan collection, Glasgow, UK; PV—paired (articulated) shell valves; V—valve (s); WAM—Western Australian Museum, Perth; ZMA—Zoological Museum, Amsterdam.

Taxonomy

Superfamily **Pectinoidea** Rafinesque, 1815
Family **Pectinidae** Rafinesque, 1815
Subfamily **Pectininae** Rafinesque, 1815
Tribe **Pectinini** Rafinesque, 1815

Genus *Pecten* Müller, 1776

Type species (by subsequent designation of Schmidt 1818): *Ostrea maxima* Linnaeus 1758; extant—eastern Atlantic.
Synonymy—see Beu 2006.

Diagnosis

The genus *Pecten* is characterised by a solid, sub-orbicular shell, of medium to large size (to at least 150 mm shell height in some species). The shell is inequivalve, with

the left valve flat or slightly concave and overlapped in many species by the strongly convex right valve. Both valves have prominent, wide radial ribs (costae), angular or rounded in cross section, with secondary radial riblets in many species. Fine commarginal lamellae are also present on most specimens, especially on the left valve. The auricles are prominent and almost equal in shape and size, with a weak byssal notch in the anterior auricle of the right valve and a weak ctenolium on juvenile shells, absent from adult shells. The hinge is the most prominent of all Pectinidae, with prominent narrow dorsal, intermediate and resilial teeth and sockets. The preradial stage of the shell is very weakly sculptured compared with the radially sculptured stage, and is easily observed on *Pecten* as it is up to 10 mm high, much larger than in other Pectinidae.

Distribution

Upper Eocene to Recent. Eastern Atlantic and Indo-West Pacific, in shallow to moderate water depths.

Remarks

Although an extensive synonymy exists for the species included in this genus, there appear to be about 14 currently recognised valid species (Raines and Poppe 2006), depending on the interpretation of recent molecular genetic research (Wilding *et al.* 1999; Saavedra and Peña 2004). A review of the literature also indicated a largely temperate and sub-tropical distribution for this genus. There appear to be few shallow-water or abundant tropical populations of *Pecten* species. Arguably, *Pecten keppelianus* G. B. Sowerby III, 1905 (West Africa) and *P. excavatus* Anton, 1838 (Japan to Indonesia) have the only trans-equatorial distributions. The only records of a tropical Australian *Pecten* we found in the literature are those by Taylor and Glover (2004: 262) as *Pecten* cf. *excavatus* from the Dampier Archipelago, northern Western Australia, and our earlier report of the present records (Duncan and Wilson 2007).

Pecten dijksrai n. sp. Figs. 1–2.

Pecten cf. *excavatus* Anton, 1839 [sic]; Taylor and Glover 2004: 262.

Pecten n. sp.; Duncan and Wilson 2007: 1306–1307.

Description

Shell medium-sized, mean dorso-ventral height 42.8 mm (SD = 3.7, n=5), mean antero-posterior length 48.0 mm (SD = 4.8, n=5), and up to a maximum shell height of 55 mm based on specimen examined by Dijkstra and Beu (pers. comm.); typical of *Pecten* in form; sub-orbicular, strongly inequivalve, with equal, well-developed auricles, hinge line straight; weak byssal notch in anterior auricle of right valve. No ctenolium present. Right valve strongly overlaps left valve.

Left valve strongly concave, with 14–16 prominent radial ribs (costae) of sub-angular profile. Weak secondary radial riblets present on some specimens. Commarginal lamellae well-defined in specimens from Gnaraloo, weaker in Exmouth Gulf specimens. Ground colour off-white, with predominantly pale pink to dark red-pink pigmentation graduated over entire valve. Distinct symmetrical white (unpigmented) chevrons, opening ventrally, centred on primary costae; each chevron with black border on closed dorsal end. Black chevron patterns connect on many specimens, particularly close to anterior and posterior ends, forming distinctive, broadly concentric zigzag lines over valve surface. Umbonal region off-white or, on most specimens, pale pink, reflecting overall valve colour. Auricles lamellate; colour reflecting general valve colour, with dark pigmented lines in few specimens.

Right valve strongly to very strongly convex, with 16–20 rather low radial ribs (costae). Ribs typically bifurcate, particularly prominent on specimens from Gnaraloo. Ground colour white or off-white, maculated extensively with small orange, pink or red blotches or striations, more prominent in Gnaraloo specimens, much paler in Exmouth Gulf specimens. Interior of both valves glossy white, with marginal pink coloration in strongly pigmented specimens. Adductor muscle scars prominent, with moderately callused margins. Juvenile stages up to around 20 mm shell height, weakly sculptured, and typical of genus (AMS C.146784, multiple specimens). Hinge prominent, with narrow, sharply defined dorsal, intermediate and resilial teeth and sockets, visible with difficulty inside right valve because of its strongly enrolled, convex shape. The dimensions of 5 specimens from off Gnaraloo and Exmouth Gulf are shown in Table 1.

TABLE 1 *Pecten dijksrai* n. sp. Shell measurements of five original specimens. Locality refers to either Gnaraloo (Gn) or Exmouth Gulf (Ex). All values are in mm, except rib (costae) number. Rib counts are external.

Specimen & locality	Height (DV)	Length (AP)	Hinge	Lateral Width	Rib Number (left valve)	Rib Number (right valve)
Holotype (Gn)	39.4	43.8	25.1	16.4	14	20
Paratype (Gn)	40.8	45.7	27.3	15.8	16	17
Paratype (Gn)	48.7	55.8	31.9	18.9	16	18
Paratype (Ex)	40.9	45.5	26.8	18.1	16	17
Paratype (Ex)	44.1	49.3	28.8	22.6	16	16
Mean ±SD (n=5)	42.8 ±3.7	48.0 ±4.8	28.0 ±2.6	18.3 ±2.7	15.6 ±0.9	17.75 ±1.7

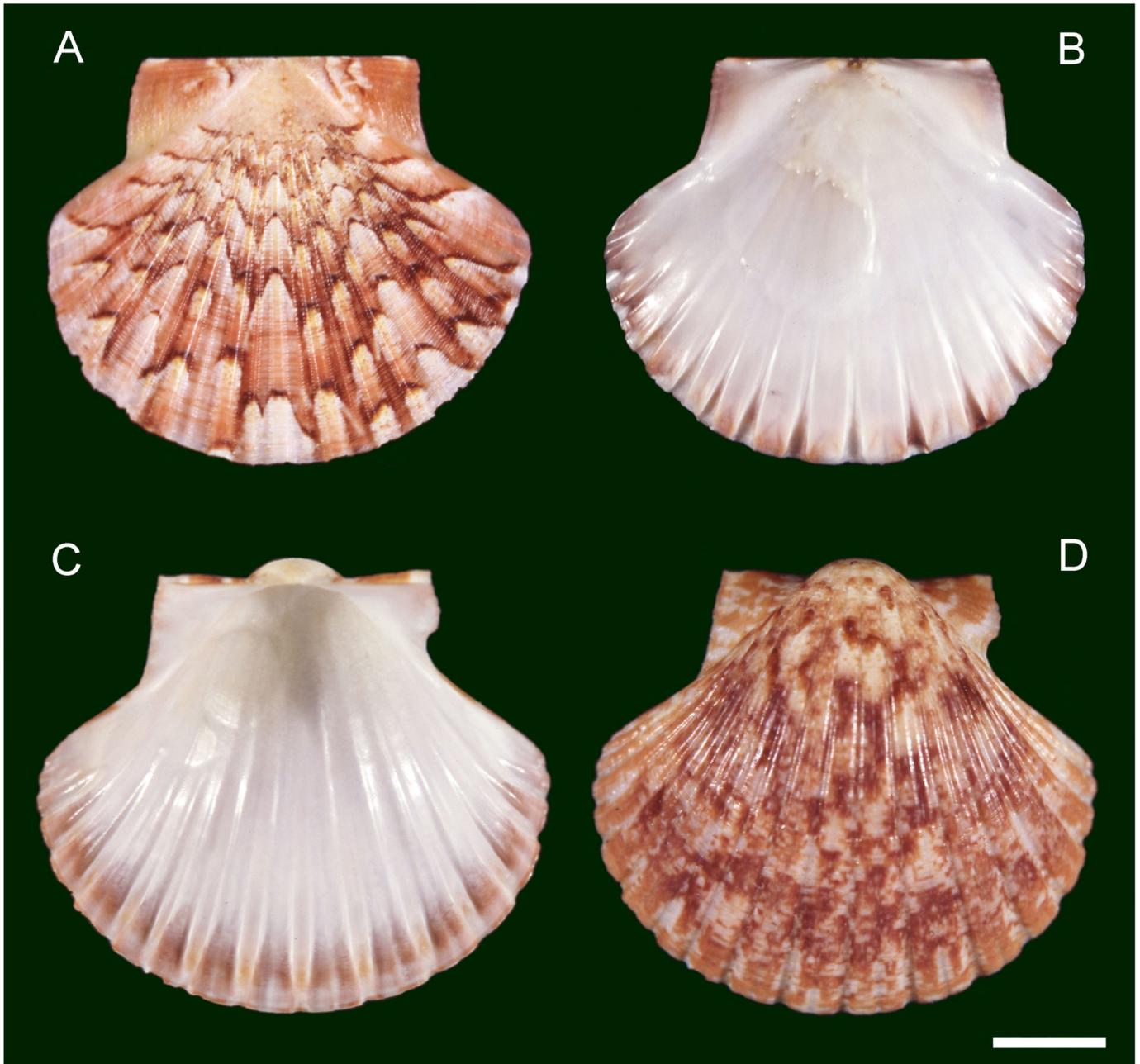


FIGURE 1 *Pecten dijksrai* n. sp. Holotype (AMS C.462684). Off Gnaraloo, Western Australia. **A, B**, left valve, **A**, exterior, **B**, interior; **C, D**, right valve, **C**, interior, **D**, exterior. Scale bar = 10 mm.

Type material

Holotype (pv) (DV 39.40 mm, AP 43.80 mm; hinge 25.10 mm, lateral width 16.40 mm) AMS C.462684, 30 paratypes (pv and v) (listed below).

Type locality

Off Gnaraloo Station, Western Australia, 23° 52' S, 113° 29' E, 40–42 m depth in areas of coral sand around low-profile, sponge-encrusted limestone reef.

Material examined

Western Australia, Off Gnaraloo Station, 130 km N of Carnarvon, 23° 52' S, 113° 29' E, dead, 40–42m, on areas of coral sand around low-profile, sponge-encrusted limestone reef (**Holotype** and 2 paratypes (pv), AMS C.462684, GW,

PD); Exmouth, north of North-West Cape, approx. 21° 32' S, 114° 24' E, dead, 35–40m, on coral sand adjacent to low profile limestone reef (2 paratypes (pv), GW, PD); North West Shelf, 52 n.ml NNE of Port Hedland, 19°30.9'S–19°28.2'S, 118°49.2'E–118°55.4'E, dead, 36–37 m, sand, dead (2 paratypes, AMS C.149192; paratype, AMS C.149173); North West Shelf, 77 n.ml NNE of Port Hedland, 19°05'S–19°04.9'S, 118°58'E–118°58.2'E, dead, 82 m, sand & gravel (paratype, AMS C.149343); North West Shelf, 78 n.ml NNE of Port Hedland, 19°04.4'S–19°04.2'S, 119°04.4'E–119°00.7'E, dead, 82 m, sand (2 paratypes, AMS C.149327); North West Shelf, 80 n.ml NNE of Port Hedland, 19°03.6'S–19°03.4'S, 119°03.4'E–119°03.5'E, dead, 82 m, sand (20 paratypes [juv-adult], AMS C.146784).

Additional material

(not examined by authors. Dijkstra and Beu; pers. comm. September 2011).

Western Australia, West of Point Quobba, 50 km N of Carnarvon, approx. 24°27'S, 113°40'E, alive, 35–40 m (single specimen, HM); Exmouth, north of N Muiron Island, 21°39'S, 114°22'E, alive, 30 m, sand & gravel (single

specimen, HM); NNE of Dampier Archipelago, 19°23'S, 117°21'E–117°23'E, alive, 101–102 m (single specimen, WAM S 30715); North West Shelf, 19°05'S, 118°50'E, alive, c. 80–100 m, muddy sand (single specimen, ZMA Moll. 409005); off Broome, 17°58'S, 122°14'E, alive, 12–18 m, coarse rubble (2 specimens, HM; single specimen, ZMA Moll. 409006).



FIGURE 2 *Pecten dijkstrai* n. sp. **A, B.** Paratype (PD). off Gnaraloo, Western Australia; **A.** left valve, anterior view **B.** right valve, anterior view. **C, D.** Paratype (PD). Exmouth Gulf, Western Australia; **C.** left valve, anterior view. **D.** right valve, anterior view. Scale bar = 10 mm.

Distribution

We know of specimens of *Pecten dijkstrai* n. sp. from off Gnaraloo Station, 130 km N of Carnarvon, 23° 52'S, 113° 29'E to as far north as North West Shelf, 80 n.ml NNE of Port Hedland, 19°03.6'S–19°03.4'S, 119°03.4'E–119°03.5'E. Dijkstra and Beu (pers. comm. September 2011) believe that the species also occurs slightly further south, (off Point Quobba, 50 km north of Carnarvon, WA (24°27'S, 113°40'E)) and slightly further north (Broome, WA (17°58'S, 122°14'E), and it seems likely that it occurs even more widely. Dijkstra (1991) reported *Pecten excavatus* from north-east of Sumba Island (9°52.8'S, 120°44.7'E) in the Savu Sea, Indonesia. His description of these specimens, reported as being similar to the original figured type specimens of *P. excavatus*, although less concave and with weaker radiation (radial costae or ribs), were considered to be within normal variation for this species. It was also a new record from Indonesia. However, we can find no other published records of *Pecten* spp. from Indonesia, Malaysia or the Philippines (Raines, in Poppe (2010) does not record *excavatus* from the Philippines). *Pecten excavatus* is recorded from Hong Kong (Bernard *et al.* 1993), but apparently not definitively between there and Indonesia, raising the unlikely possibility of a disjunct distribution for *P.*

excavatus of more than 3500 km. Alternatively, given their description, particularly the weaker radial costae, it is possible that the Indonesian shells are *Pecten dijkstrai* n.sp.

Importantly, statistical comparisons of multiple shell parameters between Japanese specimens (n=6) of *P. excavatus* and specimens of *P. dijkstrai* n. sp. (n=5) indicated several characteristics that can be used to differentiate the shells. There are significantly higher radial rib (costae) counts in *P. dijkstrai* n. sp. compared with *P. excavatus* (Mann-Whitney U test, $P < 0.01$), (counts of 15.6 ± 0.9 compared with 14.0 ± 0 for external left valves, and 17.75 ± 1.7 compared with 17.0 ± 0 for external right valves respectively) (see also Table 1). In addition, the shells of these species can also be differentiated by the ratio of dorso-vental to antero-posterior dimensions, a measure of roundness, with *P. excavatus* being more round or, alternatively, *P. dijkstrai* n. sp. being longer (0.93 ± 0.02 compared with 0.89 ± 0.01 respectively) (Mann-Whitney U test, 2-tailed, corrected for ties, $P < 0.01$) (see also Table 1). These data not only support their respective specific status, but also the possibility that *P. excavatus* does not occur in the southern hemisphere, there now being a probable alternative species to account for the Indonesian specimens.

Further records of relevance to the potential distribution of *Pecten dijkstrai* n. sp. come from the Global Biodiversity Information Index (www.gbif.org) which records data from the Australian Government's Bureau of Rural Sciences (National Commercial Fisheries Half-Degree Data Set 2000–2002). This database contains multiple unusual records of *Pecten fumatus*; two from the Torres Strait (9° 45'S, 14° 31'5"E; 10° 15'S, 143° 15'E), three from the Gulf of Carpentaria (15° 15'S, 137° 15'E; 13° 45'S, 136° 45'E; 13° 15'S, 136° 45'E) and one from north of Melville Island, near Darwin (11° 15'S, 131° 15'E). These identifications seem unlikely to be *P. fumatus*, with its well-established temperate distribution, but the recognition of it being a *Pecten* sp., given their characteristic appearance, appears more credible. We therefore speculate that these records may also refer to *Pecten dijkstrai* n. sp., and postulate that its distribution may extend as far east as the Coral Sea. Therefore, a possible revised distribution for the three *Pecten* species; *excavatus*, *fumatus* and *dijkstrai* n. sp. is proposed in Figure 3. Two species from the New Zealand region are also included for completeness.

If these proposed distributions are subsequently found to be correct, then it presents an interesting development, with potential implications for the phylogeography and evolution of *Pecten* within the Indo-Pacific region. It is perhaps noteworthy that another Australian scallop, *Amusium balloti* (Bernardi, 1861), shares a broadly similar Australasian and respectively Asian distributional relationship with its con-generic relative *Amusium japonicum* (Gmelin, 1791).

Remarks

Compared to specimens from Gnaraloo, Exmouth Gulf specimens have a more strongly concave left valve and a more strongly convex right valve, resulting in a more significant overlap of the right valve margin (Fig. 2). Colouration and patterns are also generally less intense in the Exmouth than in the Gnaraloo specimens.

Etymology

We have pleasure in naming this species in honour of Henk Dijkstra, in recognition of his significant contributions to pectinid taxonomy and allowing access to the information in his unpublished monograph of Australian Pectinidae (with Dr A. Beu) which included a provisional description of the species named herein.

Discussion

Comparison between *Pecten dijkstrai* n. sp. and the only other recognised Australian *Pecten* species, the temperate *P. fumatus*, indicated more prominent and more angular radial costae, as well as a larger, more circular and thicker shell in *P. fumatus*. However, the right valve is more convex, and the left valve more concave in *P. dijkstrai* n. sp., and the shell colour and patterns are much more vivid than the subdued colours found in *P. fumatus*. The reported northern extent of

the range of *P. fumatus* in Western Australia is Shark Bay (Raines and Poppe, 2006) (Fig. 3).

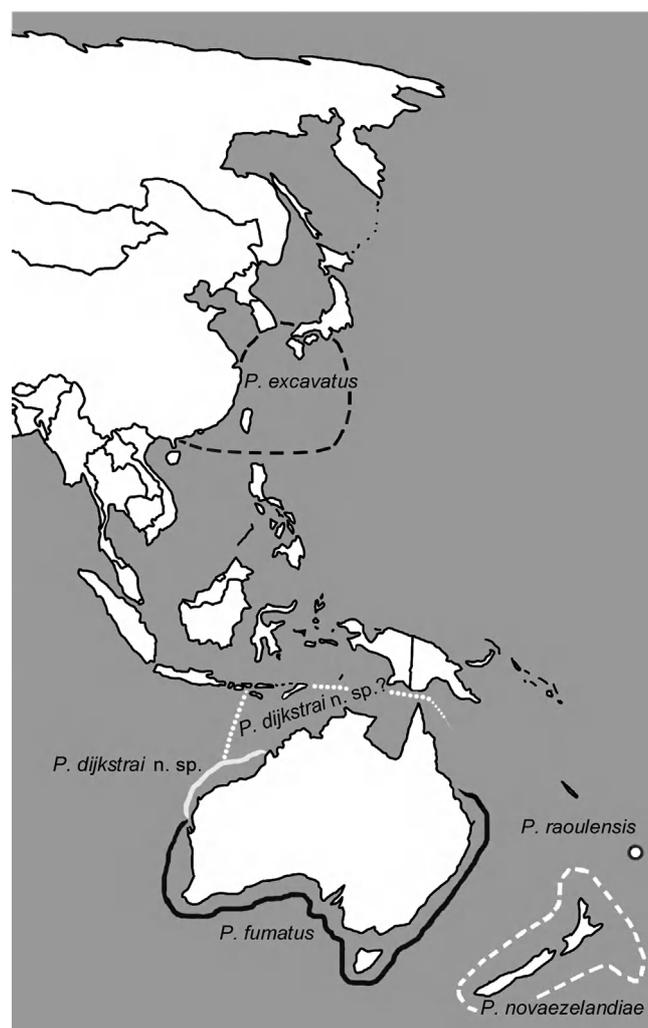


FIGURE 3 *Pecten dijkstrai* n. sp. Actual (based on material examined (Gnaraloo to Port Hedland), and additional records (Point Quobba to Broome)) (white-bounded area) and potential distribution (based on re-interpretation of published and reported occurrences of *Pecten* spp. within the region) (dotted white-bounded area). Also shown is a proposed distribution (based on published records and re-interpretation of published and reported occurrences) (broken black-bounded area) for *P. excavatus*. The distributions for *P. fumatus* (black-bounded area), *P. novaezelandiae* (broken white-bounded area) and *P. raoulensis* (white circle with black boundary) are also indicated. Latter three modified from Raines and Poppe (2006). See text for details.

Similarly, comparisons between *P. dijkstrai* n. sp. and the two other *Pecten* spp. within the Australasian region, *P. novaezelandiae* (Reeve, 1852) and *P. raoulensis* (Powell, 1958), broadly indicate the same consistent differences as with *P. fumatus*. Specifically, prominent, narrower and more angular radial costae, larger and more robust shell of subdued brown-red colouration in the New Zealand species, and more convex right valve and concave left valve in *P. dijkstrai* n. sp. The reported distributions for *P. novaezelandiae* and *P. raoulensis* do not extend outside the adjacent waters of New Zealand and the Kermadec Islands respectively (Powell 1958; Raines and Poppe 2006; Dijkstra and Marshall 2008) (Fig. 3).

The most similar species to *Pecten dijkstrai* n. sp. appears to be the Asian species *Pecten excavatus* Anton,

1838 (= *P. sinensis* G. B. Sowerby II, 1842, = *P. puncticulatus* Dunker, 1877). The type locality of *P. excavatus* is "China", and its distribution has typically been described as ranging from Japan and Korea, as far south as Hong Kong (Bernard *et al.* 1993). Other than Dijkstra's (1991) record from nearby Indonesia, the only published reference we can find to its occurrence as far south as Australia is by Raines and Poppe (2006), who showed a distribution map for *P. excavatus* from southern Japan to Java, western Papua and north-western Australia. However, as indicated above, several shell characteristics enable differentiation of the two species, and therefore *P. excavatus* may not occur south of the equator, being replaced by *P. dijkstrai* n. sp. in Australasian and southern Indonesian waters. Specimens of *Pecten dijkstrai* n. sp. that we have seen are smaller than typical Japanese specimens of *P. excavatus*, and they are also longer and less robust than the Japanese shells. The radial ribs (costae) are weaker (lower) and less angular than in *P. excavatus* and the left valve of *P. dijkstrai* n. sp. may be more deeply concave in some specimens, although this feature appears to vary with locality, and is not diagnostic (see Fig. 2). The colour of *P. dijkstrai* n. sp. is also paler than in *P. excavatus*. Other characters appear similar in the two species. To date no tissue samples of *P. dijkstrai* n. sp. have been obtained and such samples would provide useful data on phylogenetic relationships with other species of the genus. The relatively isolated locality and habitat depth of this scallop limits bottom search time by scuba divers, and therefore specimen availability at this time. However, the possibility of tissue sample collection of *Pecten* specimens across the potentially wider range proposed above may clarify this issue in future.

Differences in shell form between the Gnaraloo and Exmouth specimens of *P. dijkstrai* n. sp. may be related to local differences in substrate type or hydrology, as the relationship between shell form and such variables has been well described in the literature (Stanley 1970; Seed 1980; Dijkstra and Marshall 2008). However, there also seems to be a cline in shell shape and colouration from north to south, possibly influenced by temperature.

Two of the original specimens of *P. dijkstrai* n. sp. exhibit drill holes, likely as a result of predation by octopods.

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