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SMITHSONIAN INST.
RETURN TO W-119**A Taxonomic Revision of
Australian Species of *Paratya*
(Crustacea: Atyidae)**

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Abstract

Paratya australiensis is redescribed. A study of geographical variation showed that this species is variable but has no subspecies or congeneric species in Australia. Previously described Australian species or subspecies are synonymized with *P. australiensis*.

Introduction

Freshwater shrimps of the genus *Paratya* are widespread throughout south-eastern Australia, including Tasmania. They also occur as far north as the Atherton Tablelands on the eastern coast of Queensland; Williams (1977; Fig. 1) provides a map of this distribution. Throughout much of their range they are common in lowland rivers and streams but frequently occur in non-flowing fresh waters (Williams 1977, Table 4). *Paratya* has not been well-studied ecologically, and the taxonomic situation is confusing.

Australian material of *Paratya* was first separated as a distinct species by Kemp (1917) who referred all material examined to a single taxon: *Paratya australiensis*. Calman (1926) and, especially, Roux (1926) considered further Australian material and this too was referred to *P. australiensis*. Both Kemp (1917) and Roux (1926) drew particular attention to the morphological variability of material examined by them but refrained from describing subspecies or further species. Australian forms of *Paratya* were subsequently investigated taxonomically by Riek (1953) who recognized five taxa, viz. *P. australiensis australiensis*, *P. australiensis arrostra*, *P. atacta atacta*, *P. atacta adynata* and *P. tasmaniensis*. In an unpublished thesis, Walker (1972) concluded that all Riek's taxa were conspecific, a view supported by Williams (1977).

The present paper redescribes *P. australiensis* more fully and formally considers the status of Riek's (1953) taxa.

TaxonomyOrder **Decapoda**
Supersection **Natantia**
Section **Caridea**
Superfamily **Oplophoroida**
Family **ATYIDAE**
Paratya australiensis Kemp
(Figs 1-4)

Paratya australiensis Kemp, 1917, pp. 303–4, Fig. 5; Bouvier, 1925, p. 62, Fig. 86; Calman, 1926, pp. 241–2; Roux, 1926, pp. 239–43; Riek, 1953, pp. 113–4, Figs 1, 2; Williams, 1977, pp. 403–4.

Paratya australiensis arrostra Riek, 1953, p. 114, Fig. 2.

Paratya atacta atacta Riek, 1953, pp. 114–15, Fig. 3.

Paratya atacta adynata Riek, 1953, p. 115, Fig. 4.

Paratya tasmaniensis Riek, 1953, pp. 115–16, Fig. 5.

Material Examined

NEW SOUTH WALES: Near Sydenham Rd, Marrickville, Sydney, May, 1924, 6♂4♀, AM (Australian Museum) P7201, identified by Roux (1926) as *P. australiensis* and by Riek (1953) as *P. australiensis australiensis*; creek at Middle Harbour, Pt Jackson, Feb. 1925, 5♂1♀, AM P7919, identified as *P. australiensis* by Roux (1926); Seven Hills, 3.xii.1944, 4♂6♀ incl. 4 ovig., AM P13284, identified as *P. australiensis* by Riek (1953); upper reaches of Middle Harbour, Sydney, 17.xii.1944, 1♂1♀ ovig., AM P13283, type collection of *P. atacta adynata* Riek, 1953; Colombo R. between Urana and Narrandera, 1♀; Murrumbidgee R. at Narrandera, 1♂; L. Cowal, near Marsden, 3♂1♀; billabong of R. Lachlan, 14 km south of Forbes, 2♂2♀; 11 km south of Dubbo, 3♂1♀, SAM (South Australian Museum) C3854; Macquarie R., Dubbo, 3♂2♀, SAM C3855; Castlereigh R., Gilgandra, 1♂1♀; Wallumburrawang Ck, Warrumbungle Mountains, 3♂1♀; Keepit Dam, near Tamworth, 2♂3♀, SAM C3856; Beardy Ck, 14 km north of Glen Innes, 3♂1♀; Maryland R., 19 km southwest of Legume, 3♂1♀, SAM C3857; Hoffman's Ck, 24 km south of Woodenbong, 3♂1♀, SAM C3858; Bom Bom Ck, 74 km north of Coff's Harbour, 3♂1♀; Worrell Ck, 11 km south of Macksville, 2♂; Buleudelah, 1♂3♀; Stoney Ck, 26 km north of Raymond Terrace, 3♂1♀; Collector Ck, 2♂2♀; Picton Lakes, 3♂3♀ incl. 2 ovig.; L. Bathurst, 2♂7♀ incl. 5 ovig.; 19 km north of Bateman's Bay, 3♂3♀ incl. 2 ovig.; Sandy Ck at Tarija, 3♂1♀; Narrabarba Ck, 21 km north of Victorian border, 2♂2♀; Moorna Billabong, 1♂2♀; Darling R. Anabranch, 16 km north of Wentworth, 2♂2♀; Darling R., 56 km south of Pooncarrie, 1♂; Dixon's Dam near Narrandera, 3♂2♀; Mongarlowe R., 3♂2♀ incl. 1 ovig.; Coonabarabran, 3♂1♀; Rocky River, near Lismore, 1♂3♀; Shardon's Lagoon, Cooranbong, 2♂4♀ ovig.

AUSTRALIAN CAPITAL TERRITORY: Cotter River, 30.xii.1945, E. Riek, 5♂5♀ ovig., AM P13261, type collection of *P. australiensis arrostra* Riek, 1953.

VICTORIA: L. Jill Jill, 3♂1♀ ovig.; Emerald, 2♂; Wannon Ck, Wannon, 2♂2♀; L. Yerang, Hattah Lakes region, 2♂2♀; R. Murray, Kulkyn, 3♂1♀, SAM C3845; Ararat Ck between Pakenham and Tynong, 3♂2♀ incl. 1 ovig., SAM C3846; Tarago R. near Neerim South, 2♂1♀; L. Boga near Swan Hill, 1♀; lake near L. Charm, 3♂1♀; Hume Reservoir, 3♂2♀ incl. 1 ovig.; Cardinia Ck, 75♂83♀, 10 juv., SAM C3844 (see text); Wattle Tree Ck, 16 km north of Buchan, 1♂3♀; creek near Portland, 4♀; swamp near Fernbank, 3♂1♀; Dandenong Ck, 1♀; Thomson R. at Heyfield, 2♂1♀ ovig.; Round Lake, Kerang, 1♂4♀ incl. 3 ovig., SAM C3847; L. Hawthorn, Mildura, 1♀ ovig.; below weir at junction Loddon R. and Pyramid Ck, Kerang, 2♂2♀; Lang Lang Ck, 5 km from mouth, 1♂2♀ incl. 1 ovig.; creek near Yarraglen, 1♂3♀; creek south of Yarraglen, 3♂1♀; Wingan R., east of Cann R., 4♂, SAM C3848; Lysterfield Reservoir, 1♂3♀; Heathmont, 1♂1♀; King Parrot Ck near Kinglake West, 2♂2♀; Tarwin R., west branch, 2♀; Patterson R., 1♂1♀; L. Purrumbete, 2♂3♀ ovig.; Moylan's Bong, Wodonga, 2♂1♀; billabong of Murray R., Albury–Wodonga, 4♂; Murray R., Albury–Wodonga, 1♂2♀; Murray R., Swan Hill, 1♂3♀; L. Mulwala, Yarrawonga, 1♀; L. Moodemeerc, Rutherglen, 1♂; 56 km west of Hamilton, 1♀; Wando R., 2♀ incl. 1 ovig.; Wannon R., at foot of Mt Sturgeon, 2♀; Surrey R., south of Heywood, 1♂; Fitzroy R. at Heywood, 3♂; Darlots Ck, 1♂2♀. Ovigerous females from which eggs were counted and measured: Cardinia Ck, from 5.ix.1961 to 7.xii.1962, 130♀; Glenmaggie Reservoir, 25.xi.1962, 5♀; Toomuc Ck, 24.xi.1962, 7♀; Bunyip Ck, 24.xi.1962, 1♀; Latrobe R., 24.xi.1962, 6♀.

QUEENSLAND: Terrors Ck, Dayboro, 8.viii.1942, E. Riek, 3♂7♀ incl. 5 ovig., AM P13270, type collection of *P. australiensis arrostra* Riek, 1953; Binna Burra, Lamington National Park, 14.ix.1945, E. Riek, 5♂5♀ ovig., AM P13279, type collection of *Paratya atacta [atacta]* Riek, 1953; upper reaches of Currumbin Ck, 1.x.1953, E. Riek, 12♀ incl. 9 ovig., AM P13281 identified as *P. atacta atacta* by Riek; Palen Ck on New England Hwy, north of N.S.W. border, 2♂1♀; Ugly Ck, 2♀; Ugly Gully Ck, near Brisbane, 2♂1♀, SAM C3860; Nordellos Lagoon, near Tinaroo Falls Dam, 2♂1♀; Gold Ck, Indooroopilly, 4♂1♀ ovig., SAM C3859; Moggill Ck, Upper Brookfield, 2♂; Mary R., Conondale, 2♂1♀; Terrors Ck, 6–5 km north of Dayboro, 3♂2♀, SAM C3861; Dawson R., 2♀; Wallaman Falls near Mackay, 5♂, SAM C3863; Burnett R., near Bundaberg, 3♂1♀; Chittern Springs, Nerang R., 1♂; Tallebudgera R. at pumping station, 3♂1♀ ovig.; Tallebudgera R., near Ingleside, 1♀; Currumbin Ck near Titirangi, 4♀ incl. 1 ovig.; Coomera R. near R.S.L. Hall, 1♀; Coomera R. near Maudsland, 2♂3♀; Kilcoy Ck, 2♂3♀, SAM C3862.

SOUTH AUSTRALIA: L. Alexandrina, 2♂2♀ incl. 1 ovig.; L. Albert, 2♂2♀; Botanic Gardens Ck, Adelaide, 2♂1♀; R. Torrens at University footbridge, 5♂2♀, SAM C3839; Fourth Ck at Norton Summit, 4♂1♀, SAM C3843; Finniss R. east of Yundi, 3♂1♀; R. Torrens at Windsor Gardens, 1♂; Finniss R. near

Yundi, 5♂; Murray R. at Tailern Bend, 1♀; Torrens R., 2 km east of Gumeracha 5♂; Marne R., 4 km east of Eden Valley, 3♂ 2♀, SAM C3840; Sturt Ck, 8♀ ovig.; Jerusalem Lake, east of Pt Macdonnell, 4♀; Deep Ck east of Pt Macdonnell, 3♀; Reedy Ck drain, 1♂; Deep Ck at cheese factory, 1♂; Mosquito Ck at Robinsons Bridge, 1♂ 4♀ ovig., SAM C3842.

TASMANIA: Creek at Yates Seed Farm, on Kingston Rd, fresh water just above tide, 10.i.1947, E. Riek, 3♂ 7♀ incl. 4 ovig., AM P13273, type collection of *Paratya tasmaniensis* Riek, 1953; Derwent R. near Bridgewater, 2♂ 3♀ ovig., SAM C3852; Derwent R. south side, 6 km upstream from Bridgewater, 2♂ 2♀; L. Sorell, 2♂ 2♀; L. Sorell at Interlaken, 1♂ 1♀; L. Sorell, 3♂ 2♀, SAM C3853; Coal R. at Colebrook, 3♂ 2♀, SAM C3851; Agnews lagoon near L. Sorell, 1♂ 4♀ ovig., SAM C3849; Jordan R. at Melton Mowbray, 2♂ 2♀ ovig.; R. Clyde at Bothwell, 1♂ 2♀; Meander R., Deloraine, 2♂ 2♀; Isis R. at Barton, 2♂ 2♀; backwater of S. Esk R., Longford, 1♂ 3♀; Elizabeth R. at Campbell Town, 1♂ 6♀; L. Leake, Campbell Town, 1♂; Brushy R. near Cranbrook, 3♂ 1♀, SAM C3850; L. Crescent, 2♀ ovig.

Type Material

Proposed neotype: ♂, AMP28693. In the original description, Kemp (1917) noted that as 'types' (sic) he had selected a number of specimens from Clyde, near Sydney. These were numbered 7590–2/10 in the Zoological Survey [of India] register. However, in a footnote (p. 304), Kemp further noted that 'owing to a very unfortunate accident the types have been destroyed since the description was drawn up. The only portions of them that remain are certain appendages mounted on slides for microscopic examination.' We are informed by Dr M. Koshy, zoologist at the Zoological Survey of India, that this material too is no longer available (personal communication, 16.v.1977). It appears that primary type material designated by Kemp no longer exists.

Since Kemp's original description is incomplete and lacks any reference to female material, the designation of a neotype was considered necessary in the present revision. Attempts were therefore made (30.vi.1977) to collect topotypic material from Clyde, near Sydney. These attempts were unsuccessful (perhaps because *Gambusia affinis*, an introduced fish and known predator of atyid larvae, was common in the areas searched). Further, a single specimen of a freshwater shrimp in the collections of the Australian Museum labelled as a topotype of *Paratya australiensis* on examination proved to belong to the genus *Macrobrachium*. Among material in the collections of the Australian Museum, however, was a sample (P13284) from Seven Hills, near Sydney, a locality only 10 km north-west of Clyde. The contained labels read: (1) 'Seven Hills Sydney *Paratya* 3–4 Dec 44'; (2) '*Paratya australiensis*'; (3) '*Paratya australiensis* Kemp'; and (4) 'P13284'. This material was presented to the Australian Museum by E. F. Riek and is mentioned by him (1953) and was clearly examined and referred by him to what he regarded as the nominate subspecies of *P. australiensis*. It was from this material that a neotype was selected. The specimen chosen was the largest and least damaged male.

Description of Neotype (♂)

Size. Length from rostrum tip to telson tip, 30 mm.

Rostrum (Fig. 1a). Long, extending beyond both antennular peduncle and scaphocerite, moderately slender and pointed; dorsally armed with 28 movable teeth, 2 behind eye orbit; ventrally with 7 large serrations; dorsal edge very slightly concave, distal third of ventral edge more or less straight; length/depth, 12·4; length 1·5 times length of scaphocerite.

Eyes (Fig. 1a). Well-developed, darkly pigmented.

Carapace (Fig. 1a). Supraorbital spine large and distinct, antennal spine smaller;

pterygostomian spine indistinct, but pterygostomian angle quite acute; hepatic spine absent.

Antenna 1 (Figs 1*b*, 1*c*). Maximum length about half body length. Peduncle not quite reaching distal tip of scaphocerite, but same length as scaphocerite itself;

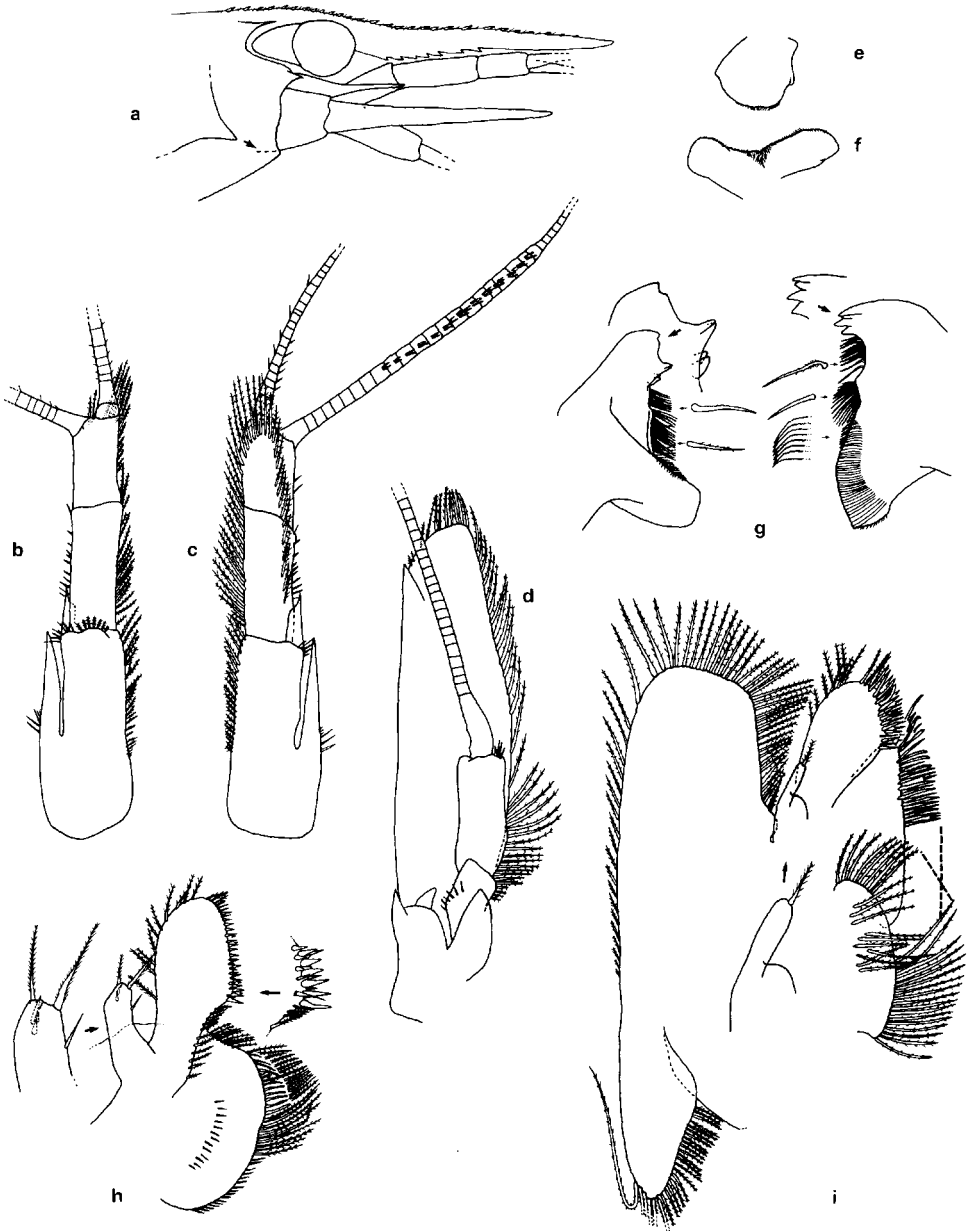


Fig. 1. *Paratya australiensis*, neotype (δ): *a*, head region; *b*, dorsal surface of antenna 1; *c*, ventral surface of antenna 1; *d*, antenna 2; *e*, labrum; *f*, paragnatha; *g*, mandibles; *h*, maxilla 1; *i*, maxilla 2.

peduncle with numerous finely setose spines in row near lateral, ventral and distal margins and along medial edge; lateral distal angle of first segment with prominent acute process; first segment ~ 1.5 times length of second and about twice length of

third. Stylocerite reaching to distal border of first peduncle segment. Flagella of about equal length, long, simple and slender; basal part (~20 segments) of outer flagellum thicker than distal part and inner flagellum, and ventrally with 0–5 aesthetascs per segment.

Antenna 2 (Fig. 1d). Longer than body. Peduncle about half length of scaphocerite; first segment without setae, overlapping second segment dorsally, and with prominent tooth at outer distal angle; second segment with short row of setae dorsally; third segment with group of setae at inner distal angle. Scaphocerite about three times as long as wide, with regular row of setose spines on inner and distal margins; outer margin extending to a sharp point overreached by lamella. Flagellum long and slender.

Lips (Figs 1e, 1f). Labrum broadly rounded and setose on lower surface and distal margin. Paragnatha bilobed and setose on inner margins.

Mandibles (Fig. 1g). Left mandible with 4 teeth separated by finely-ridged notch from a less distinct apical tooth; spine row immediately below incisor process of 8 rugose spines; spine row above molar process of ~20 sparsely setose spines. Right mandible with 4 teeth in incisor process; spine row immediately below teeth with 10 spines each finely setose basally; spine row above molar process of ~16 simple spines. Molar processes ridged.

Maxilla 1 (Fig. 1h). Lower lacinia with broadly rounded inner margin bearing 2 spine rows, 1 of long setose spines, 1 of shorter spines dentate distally; submarginal row of simple spines also present. Upper lacinia oval but inner edge more or less straight with numerous teeth in 3 rows; several setose spines on outer, distal and inner lower margins. Palp short, truncate, with 2 long, setose terminal spines and 3 simple subterminal ones.

Maxilla 2 (Fig. 1i). Upper endite deeply cleft and inner and distal margins with numerous setose, rugose or simple spines. Lower endite with marginal row of long setose spines and several submarginal spines also. Palp small, terminal part narrow and with single setose spine. Scaphognathite with regular row of setose spines on distal and inner proximal margins and several long setose spines at tip of proximal triangular process.

Maxilliped 1 (Fig. 2a). Endite of coxa with several long setose spines in regular submarginal row and smaller setose spine rows on surface. Endite of basis long and narrow and with numerous simple, denticulate or pectinate spines on inner and distal margins; regular row of long setose spines on body of endite. Palp with broad base, short narrow distal lobe, and several long setose spines on distal margins. Exopod flagellum distinct, well-developed and with numerous long setose spines on all margins; caridean lobe broad with numerous short setose spines on outer margins and a few on body of lobe. Epipodite small.

Maxilliped 2 (Fig. 2b). Ultimate and penultimate segments of endopod indistinctly divided, reflected against basal segments; medial margin of ultimate segment straight and with regular row of simple or serrate teeth-like spines; medial margin of penultimate segment with numerous long pectinate, setose or simple spines; medial margins of basal segments with numerous long setose spines. Exopod long and narrow, several setose spines of various lengths near tip and basally. Epipodite with podobranch.

Maxilliped 3 (Fig. 2c). Endopod with 3 distal segments of similar length, each several times longer than wide; ultimate segment with several transverse spine rows near base and numerous teeth-like spines on medial distal edge; penultimate and antepenultimate segments with several short simple spines. Exopod long and narrow,



Fig. 2. *Paratya australiensis*, neotype (δ): a, maxilliped 1; b, maxilliped 2; c, maxilliped 3; d, pereopod 1; e, pereopod 2.

tip over-reaching distal end of antepenultimate endopod segment; with several long setose spines near tip and several short setose spines near base. Epipodite with basal conical projection. Arthrobranch and pleurobranch present.

Branchial Formula. The formula for maxillipeds and peraeopods is given as follows (+, present, -, absent);

	Maxillipeds			Peraeopods				
	1	2	3	1	2	3	4	5
Pleurobranch	-	-	+	+	+	+	+	+
Arthrobranch	-	-	+	-	-	-	-	-
Podobranh	-	+	-	-	-	-	-	-
Epipodite	+	+	+	+	+	+	+	-
Exopodite	+	+	+	+	+	+	+	+

Peraeopod 1 (Fig. 2d). Chelae long and slender, 3·5 times as long as wide, slightly longer than carpus; fingers about as long as palm; tips evenly rounded and with numerous long rugose, pectinate or setose spines; movable finger also with 2 short terminal nails, fixed finger with 1. Carpus about 3 times as long as greatest width, broadening distally, distal margin excavate, with submarginal row of short simple spines. Merus slightly longer than carpus, parallel-sided. Ischium about half length of merus. Exopod, epipodite, and setobranh tuft well-developed.

Peraeopod 2 (Fig. 2e). Chelae long and slender, 3·5 times as long as wide, nearly two-thirds length of carpus; fingers about as long as palm; finger tips with similar spine arrangement to chelae of peraeopod 1. Carpus almost 7 times as long as greatest width, slightly broader distally, distal margin with small excavation. Merus distinctly shorter than carpus, parallel-sided. Ischium about as long as merus. Exopod, epipodite and setobranh tuft well-developed.

Peraeopod 3 (Fig. 3a). Distinctly longer than peraeopod 2 and more slender. Dactylus nearly one-third length of propodus, with prominent terminal claw and 11 strong spines on medial margin. Propodus almost 10 times as long as wide. Carpus two-thirds length of propodus, 5·6 times as long as wide. Merus slightly shorter than propodus and ischium distinctly so; merus with 2 strong spines on medial margin and 1 near ventral distal margin. Exopod, epipodite and setobranh tuft well-developed.

Peraeopod 4 (Fig. 3b). Similar to peraeopod 3 but overall slightly longer, and with only 1 strong spine on medial margin.

Peraeopod 5 (Fig. 3c). Longer and more slender than peraeopod 4. Dactylus about one-third length of propodus, with prominent terminal claw and very regular, comb-like row of numerous (56) small spines on medial margin. Propodus almost 10 times as long as wide. Carpus about two-thirds length of propodus, 5·2 times as long as wide. Merus slightly shorter than propodus, with 2 strong spines; ischium less than half length of propodus. Exopod and setobranh tuft well-developed; epipodite absent.

Pleopod 1 (Fig. 3d). Endopod slightly less than half length of exopod; broadly ovate basal portion separated by distinct V-shaped notch from triangular appendix interna; inner margin of endopod with numerous teeth-like spines; tip of appendix interna with many retinacula; outer distal margin of endopod with several long spines distally pectinate. Exopod with numerous marginal setose setae. Peduncle without long spines, but with some short ones.

Pleopod 2 (Fig. 3e). Endopod not quite as long as exopod; with numerous long setose spines on margins; appendix masculina shorter than and about twice as broad as

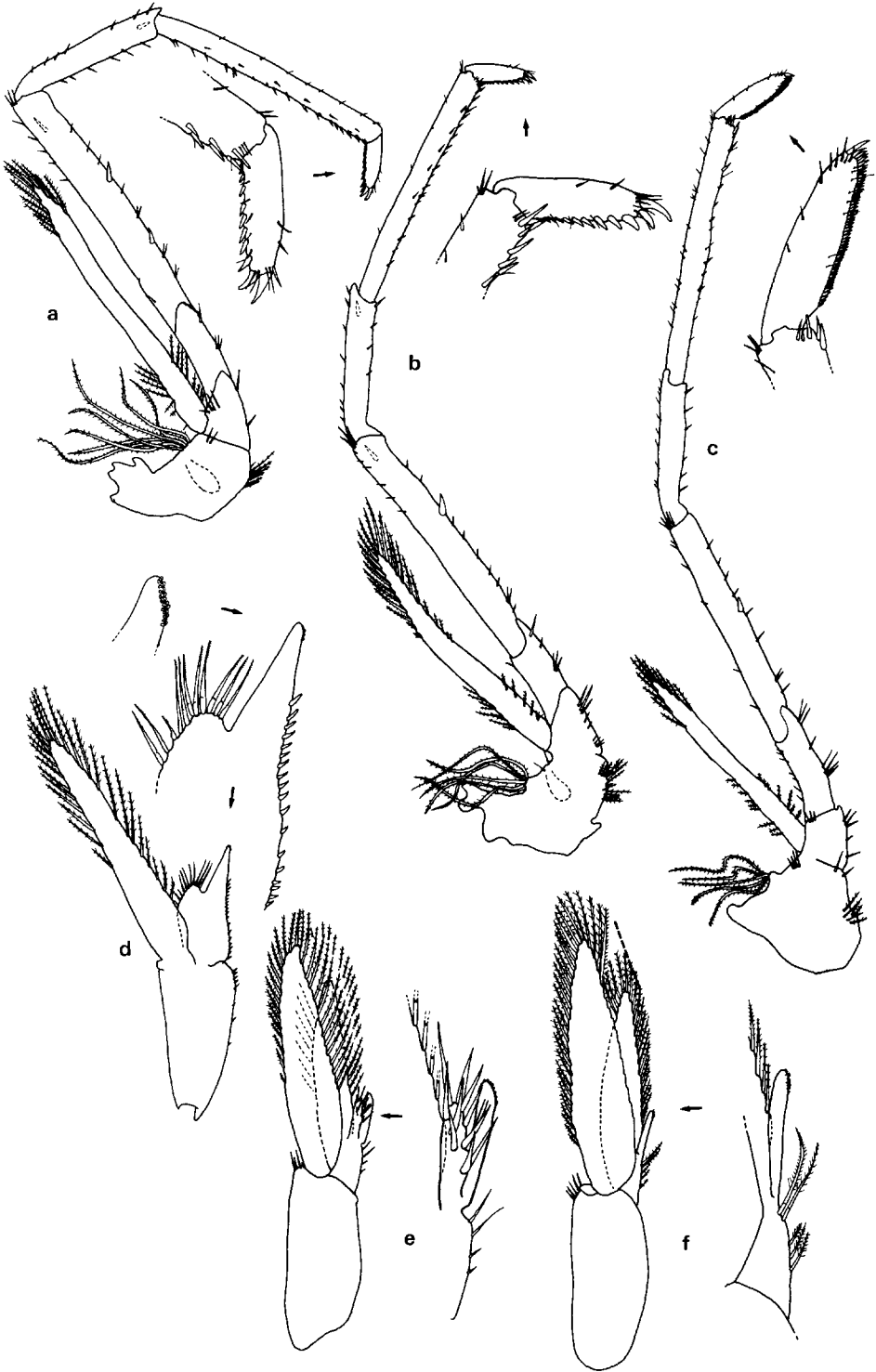


Fig. 3. *Paratya australiensis*, neotype (δ): a, peraeopod 3; b, peraeopod 4; c, peraeopod 5; d, pleopod 1; e, pleopod 2; f, pleopod 3.

appendix interna and with 12 robust spines on body; appendix interna without spines but with many retinacula at distal end. Exopod margin with numerous long setose spines. Peduncle without long spines.

Pleopods 3, 4, 5 (pleopod 3, Fig. 3f). Similar to pleopod 2 but lacking appendix masculina, and pleopod 5 with long setose spines on lateral margin.

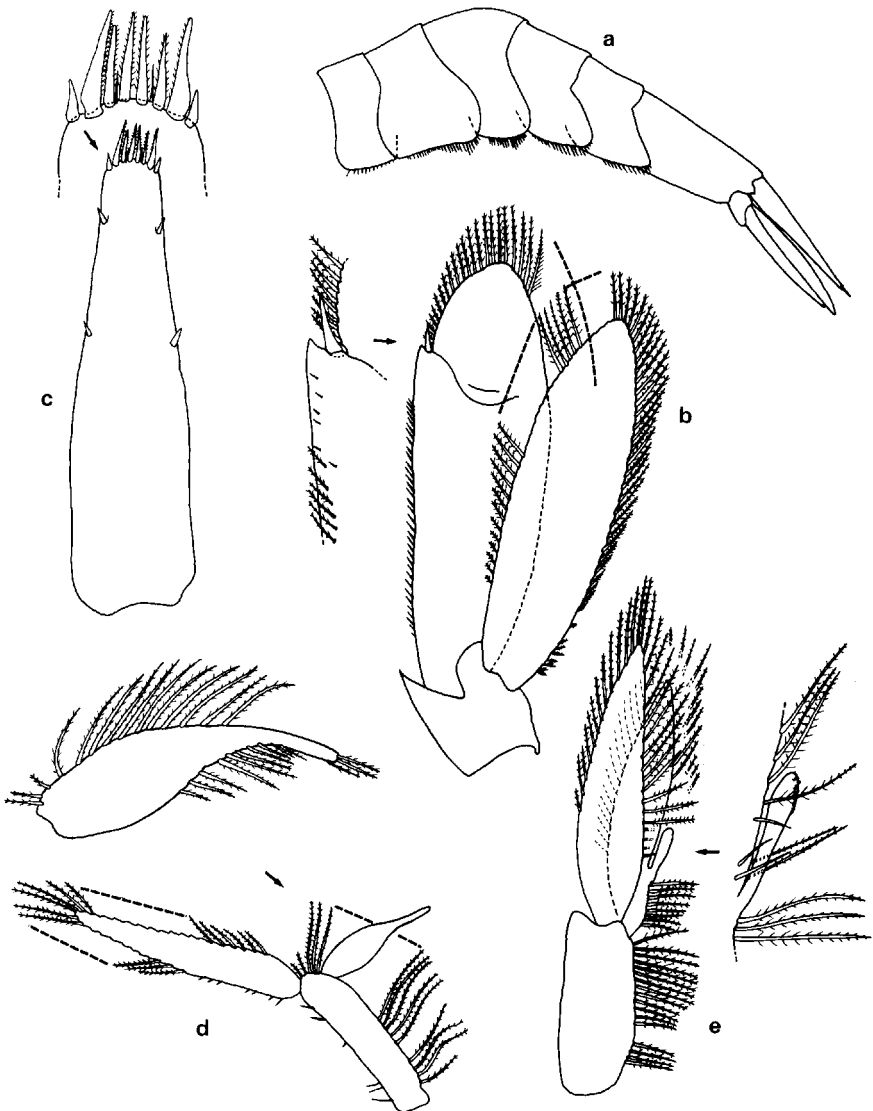


Fig. 4. *Paratya australiensis*: a–c, neotype (♂); d, e, topotype (♀). a, epimeral plates; b, uropods; c, telson; d, pleopod 1; e, pleopod 2.

Epimeral plates (Fig. 4a). Anterior and posterior angles of first 4 epimera broadly rounded; fifth epimeron with broadly rounded anterior angle but acutely rounded posterior angle. Ventral margins of all epimera with numerous small simple spines; spines absent elsewhere. Abdominal segment 6 with distinctly pointed posterolateral angle.

Uropods (Fig. 4b). Outer margin of exopod with submarginal row of short and mostly setose spines and ending in a single tooth-like spine (no spines on diaeresis apart from this). Remaining margins of exopod with numerous long setose spines. Endopod slightly shorter than exopod, with numerous long setose spines on all margins.

Telson (Fig. 4c). About as long as abdominal segment 6, over 3·5 times as long as greatest width, and tapering distally. Dorsal surface with 2 pairs of strong submarginal teeth-like spines. Posterior margin convex with 1 pair of teeth-like spines outermost, 3 pairs of long strong setiferous spines, and two simple setae.

Description of Female Topotype

The collection from which the neotype was selected also contained several female specimens. These represent topotypes from a type locality restricted by subsequent designation. One ovigerous female was fully dissected and is described below in so far as it exhibits significant differences from the neotype.

Pleopod 1 (Fig. 4d). Endopod about half length of exopod, narrowly ovate at base and tapering distally with numerous long setose spines on lateral and medial distal margins, and 3 long setose spines at tip. Peduncle with several long setose spines on medial margin.

Pleopod 2 (Fig. 4e). Appendix masculina absent. Medial proximal margins of endopod (below appendix interna) and medial margins of peduncle with numerous long setose spines.

Pleopods 3, 4. Medial proximal margin of endopod (below appendix interna) and medial margin of peduncle with numerous long setose spines.

Pleopod 5. Medial margin of peduncle with fewer setose spines than pleopods 3 and 4.

Eggs. Total number on pleopods 154. Mean length and width \pm s.d. of 50 eggs (ranges in parentheses) are respectively $0\cdot80 \pm 0\cdot03$ mm ($0\cdot70$ – $0\cdot84$ mm) and $0\cdot48 \pm 0\cdot01$ mm ($0\cdot44$ – $0\cdot50$ mm).

Further Description

A series of collections from Cardinia Creek, Beaconsfield, Vic., of a taxon considered conspecific with the neotype allows comprehensive further description. These collections formed the basis of a life history study of this species (Williams 1977). They were examined to provide indications of morphological variation between sexes and with size and season. Size variation was investigated by examining at least five specimens of each sex of total lengths 15, 20 and 25 mm. Additionally, 2♀ 34 mm long were examined. Seasonal variation was investigated by examining 11 collections obtained at approximately 6-weekly intervals between January and December 1962. From each collection, at least 5♂ and 5♀ 20 mm long were examined. Variation in egg size and number was investigated by examining a total of 130 ovigerous females of different sizes and collected throughout the breeding seasons of 1961 and 1962.

Apart from differences in maximum body length and the sexual difference in pleopod morphology indicated above, morphological differences between males and females are relatively minor (Table 1). Seasonal differences in morphology are also minor and are statistically non-significant. With regard to differences due to size:

- (1) there are no consistent trends in the proportions of appendage segments;
- (2) rostral spine number increases with increasing size;
- (3) in general, older (larger) animals have more spines than younger (smaller) ones,

this being most clearly seen in the peraeopod 5 dactylus which in animals 11–12 mm long bears 19–35 spines, and in animals 25–34 mm bears 53–69 spines; and

(4) secondary sexual characters become distinguishable at ~12–13 mm total length.

Finally, concerning egg size and number, analysis of variance indicated that egg length does not differ significantly at the 5% level at early and late stages of egg development, or with size of female, or time within breeding season. Egg width shows significant variation ($P < 0.01$) with egg developmental stage. Egg number per brood does not differ significantly during the breeding season, but is significantly correlated with female size. The equation describing the correlation for this population is: $y = 16.75x - 326.7$, where y is egg number and x the total length of the female in millimetres. $r^2 = 0.74$.

Full consideration of morphological variation within this population will be given elsewhere.

Table 1. Some morphological characters (non-pleopodal) in which males differ from females

Data refer to a population of *P. australiensis* in Cardinia Creek, Victoria, and to animals of body length 18–22 mm collected throughout the year

Character	Males			Females			Significance of difference
	<i>n</i>	\bar{x}	s.e.	<i>n</i>	\bar{x}	s.e.	
Antennular peduncle length/ scaphocerite length	62	1.004	0.0044	62	0.938	0.0031	$P < 0.001$
Peraeopod 3 propodus length/width	61	10.5	0.0822	59	9.82	0.0803	$P < 0.001$
Peraeopod 4 propodus length/width	62	10.2	0.0901	59	9.69	0.0859	$P < 0.001$
Peraeopod 5 propodus length/width	55	10.25	0.1505	60	9.24	0.0961	$P < 0.001$
Peraeopod 5 propodus length/ dactylus length	54	3.23	0.0252	60	3.00	0.0178	$P < 0.001$

Male and Female

Size. Male maximum length 32 mm, female 35 mm.

Rostrum. Long, tip usually reaching beyond antennular peduncle and scaphocerite, 0.8–1.3 length of scaphocerite; armed dorsally with 9–31 teeth, 0–3 behind eye orbit, ventrally with 0–9 teeth; dorsal edge slightly convex to concave, distal third of ventral edge straight to slightly convex; length/depth 8.5–18.6.

Carapace. Pterygostomian angle obtuse to acute.

Antenna 1. Peduncle 0.8–1.2 length of scaphocerite; first segment 1.5–2.1 length of second segment and 2.1–3.5 length of third segment. Stylocerite 0.8–1.1 length of first peduncle segment.

Antenna 2. Peduncle 0.4–0.6 length of scaphocerite. Scaphocerite 2.8–3.8 as long as wide.

Mandibles. Left mandible with 3–5 teeth (usually 4) in group separated by notch from single terminal tooth; spine row below incisor process of 4–9 spines. Right mandible with 3–6 teeth (usually 4) in incisor process; spine row below teeth with 5–10 spines.

Maxilla 1. Palp with 1 or 2 long setose terminal spines, and 1–3 simple subterminal ones.

Table 2. Geographical variation in some proportional meristic characters of *P. australiensis* arranged on a State basis. Data for Cardinia Creek represent absolute ranges recorded in this well-studied population (see text). Other meristic data are ranges of mean values between samples

Character	Cardinia Ck	Qld	N.S.W.	Vic.	Tas.	S.A.
Numbers of samples examined	11	13 or 14	28-30	37-41	16 or 17	7-9
Number of specimens examined	168	38-52	92-116	99-125	48-62	52-60
1. Rostrum length/width	8.5-18.6	6.98-11.45	7.20-11.87	7.08-13.53	7.45-10.40	7.66-11.20
2. Rostrum length/ scaphocerite length	0.8-1.3	0.89-1.61	0.82-1.66	1.06-1.44	1.12-1.41	1.05-1.30
3. Stylocerite length/ ant. 1 seg. 1 length	0.8-1.1	0.99-1.13	1.04-1.23	0.97-1.25	0.93-1.18	1.05-1.11
4. Scaphocerite length/width	2.8-3.8	3.04-3.47	2.93-3.79	2.79-4.33	3.15-3.64	2.98-3.67
5. Ant. 1 peduncle length/ scaphocerite length	0.8-1.2	0.95-1.03	0.83-1.04	0.87-1.12	0.85-1.02	0.90-1.01
6. Ant. 2 peduncle length/ scaphocerite length	0.35-0.6	0.39-0.48	0.39-0.48	0.35-0.48	0.41-0.45	0.37-0.47
7. Maxilliped 3. terminal seg. length/ penult. seg. length	0.9-1.2	0.90-1.07	0.89-1.09	0.91-1.14	0.90-1.03	0.97-1.11
8. Peraeopod 1 propodus length/width	1.9-4.1	2.05-2.90	1.98-3.60	2.19-3.18	2.18-3.17	2.18-3.22
9. Peraeopod 1 dactylus/propodus length	0.4-0.6	0.48-0.54	0.46-0.55	0.46-0.54	0.49-0.56	0.47-0.53
10. Peraeopod 1 carpus length/width	1.6-2.7	1.71-3.04	1.70-3.34	1.90-3.13	1.98-2.94	1.87-3.14
11. Peraeopod 1 propodus/carpus length	1.1-1.5	1.08-1.43	1.04-1.37	1.11-1.35	1.18-1.35	1.16-1.32
12. Peraeopod 2 propodus length/width	2.3-4.7	2.49-3.89	2.57-4.03	2.91-3.88	2.86-3.83	2.68-3.86
13. Peraeopod 2 dactylus/propodus length	0.5-0.6	0.52-0.59	0.50-0.60	0.50-0.59	0.54-0.60	0.53-0.58
14. Peraeopod 2 carpus length/width	4.4-7.4	4.66-7.87	4.90-10.7	5.05-7.86	5.49-9.17	5.21-7.39
15. Peraeopod 2 propodus/carpus length	0.6-0.8	0.53-0.78	0.57-0.71	0.56-0.70	0.58-0.75	0.59-0.69
16. Peraeopod 3 propodus length/width	8.2-13.6	8.82-11.8	8.14-13.0	8.22-11.92	8.10-11.20	7.86-10.13
17. Peraeopod 3 dactylus/propodus length	0.25-0.33	0.24-0.33	0.24-0.31	0.24-0.30	0.25-0.31	0.27-0.33
18. Peraeopod 3 carpus length/width	3.7-7.7	3.92-5.18	3.96-6.58	4.0-5.62	3.75-6.07	3.87-5.00
19. Peraeopod 4 propodus length/width	7.7-12.2	7.96-11.8	8.44-13.7	8.86-11.5	8.42-10.73	8.00-10.45
20. Peraeopod 4 dactylus/propodus length	0.24-0.34	0.24-0.33	0.25-0.32	0.24-0.30	0.25-0.29	0.28-0.32
21. Peraeopod 4 carpus length/width	3.4-6.7	3.40-5.27	3.64-5.74	3.79-5.36	3.93-5.50	3.67-4.29
22. Peraeopod 5 propodus length/width	6.8-12.5	8.80-15.42	8.50-13.9	9.38-11.38	8.05-13.0	8.63-9.88
23. Peraeopod 5 dactylus/propodus length	0.2-0.4	0.28-0.36	0.27-0.35	0.27-0.36	0.29-0.39	0.30-0.35
24. Peraeopod 5 carpus length/width	3.3-6.2	3.25-5.43	3.65-5.86	3.50-5.11	3.67-4.80	3.71-4.39

Table 3. Geographical variation in some non-proportional meristic characters of *P. australiensis* arranged on a State basis

Data arranged as in Table 5

Character	Cardinia Creek	Qld	N.S.W. ^A	Vic.	Tas.	S.A.
No. of samples examined	11	11-14	27-30	31-40	16-17	8-9
No. of specimens examined	78-163	28-54	70-117	61-121	29-59	36-63
1. Egg length (mm) ^B	0.76-0.92 (107)	0.60-0.89 (4)	0.63-0.84 (6)	0.51-0.91 (16)	0.50-0.70 (5)	0.55-0.88 (3)
2. Egg number per female ^B	29-309 (119)	100.5-215 (4)	43.5-443 (6)	90.5-574 (16)	166-1167 (5)	70-260 (3)
3. Dorsal rostral teeth	9-31	15-36	3.3-32.8	18.3-28	11.3-24.2	19.8-28
4. Ventral rostral teeth	0-9	1.5-8	0-9.8	1.5-9.7	2-10.8	2.3-7.0
5. Peraeopod 3 dactyl spines	6-11	6-10.5	7-14	7-12	6.3-9.7	8-11.0
6. Peraeopod 4 dactyl spines	6-12	7-9.3	6.8-13	7-12	6.7-9	8-11.0
7. Peraeopod 5 dactyl spines	19-69	37.5-65	43-74	36.3-77	24.3-70	46-63
8. Spines on appendix masculina	1-9	5.5-9.5	7-11	5-11.5	3-9.5	5-10
9. Telson pairs dorsal spines	1-3.5	3	3-3.25	3-3.5	3-3.2	3-3.05
10. Telson No. terminal spines	5-8	5.5-10	6-10	6-10	4.5-7.8	7-9.3

^A Including samples from the Australian Capital Territory.

^B Numbers in parentheses represent number of females examined (Cardinia Creek) or number of samples examined.

Table 4. A comparison of mean egg length (\bar{x}) in four populations of *P. australiensis* in southern Victoria

The data refer to material collected in November 1961, and were compared by *t*-test

		Glenmaggie Reservoir	Toomuc Creek	Latrobe River	Cardinia Creek
	\bar{x} (mm)	0.652	0.839	0.660	0.839
	s.e.	0.078	0.185	0.112	0.049
	<i>n</i>	5	7	6	47
Glenmaggie Reservoir	<i>t</i>		8.02	0.49	12.16
	d.f.		10	9	50
	<i>P</i>		< 0.001	n.s.	< 0.001
Toomuc Creek	<i>t</i>			7.9	0.03
	d.f.			11	52
	<i>P</i>			< 0.001	n.s.
Latrobe River	<i>t</i>				12.52
	d.f.				51
	<i>P</i>				< 0.001

Table 5. Meristic characters selected for comparison in Table 6

Number	Character	Number	Character	Number	Character
1	rostrum length/depth	10	peraeopod 1 propodus length/dactylus length	17	peraeopod 4 number dactylus spines
2	rostrum length/scaphocerite length	11	peraeopod 2 carpus length/width	18	peraeopod 5 propodus length/dactylus length
3	number dorsal rostral spines	12	peraeopod 2 carpus length/propodus length	19	peraeopod 5 number dactylus spines
4	number postorbital rostral spines	13	peraeopod 2 propodus length/dactylus length	20	telson number dorsal spine pairs
5	number ventral rostral spines	14	peraeopod 3 propodus length/dactylus length	21	telson number terminal spines
6	stylocerite length/length ant. 1 seg. 1	15	peraeopod 3 number dactylus spines	22	egg number
7	ant. 1 peduncle length/scaphocerite length	16	peraeopod 4 propodus length/dactylus length	23	egg length (mm)
8	peraeopod 1 carpus length/width				
9	peraeopod 1 carpus length/propodus length				

Table 6. Comparison between Riek's putative paratype series and named material of *Paratyta* for the meristic characters of Table 5

Character No.	<i>P. australiensis</i> (P13284)	<i>P. australiensis</i> (P7919)	<i>P. australiensis</i> (P13270)	<i>P. australiensis</i> (P13261)	<i>P. atacta atacta</i> (P13279)	<i>P. atacta atacta</i> (P13281)	<i>P. atacta adynata</i> (P13283)	<i>P. tasmaniensis</i> (P13273)	Material ex <i>Cardinia</i> Creek
1	9.6-12.4	8.6-10.0	5.7-12.3	6.7-10.9	7.1-9.4	7.2-8.7	6.1, 6.5	6.3-9.2	8.5-18.6
2	1.2-1.6	1.1-1.3	0.9-1.0	1.0-1.2	0.9-1.1	1.1-1.3	0.9	1.2-1.5	0.8-1.3
3	15-36	22-31	17-23	18-25	15-25	22-33	16, 25	23-28	9-31
4	1-3	0-3	1-3	1-2	1-3	1-4	1, 2	2-4	0-3
5	3-7	3-9	3-8	2-6	1-8	2-8	5, 9	6-15	0-9
6	1.0-1.1	0.9-1.1	1.0-1.1	0.9-1.1	0.9-1.2	1.1-1.3	0.9, 1.1	1.1-1.3	0.8-1.1
7	0.9-1.0	0.9-1.0	0.9-1.1	0.9-1.1	0.9-1.1	0.8-1.0	1.0, 1.1	0.8-1.0	0.8-1.2
8	2.2-2.8	1.8-2.3	1.3-2.3	1.9-2.3	1.7-2.4	1.7-2.2	2.0, 2.7	2.0-2.7	1.6-2.7
9	0.7-0.9	0.7-0.8	0.5-0.7	0.7-0.8	0.6, 0.75	0.6-0.7	0.7, 0.8	0.7-0.9	0.7-0.9
10	1.8-2.2	1.9-2.2	2.0-2.4	1.9-2.3	1.9, 2.3	1.8-2.2	1.9, 2.1	2.0-2.3	1.6-2.4
11	6.7, 7.4	6.9	5.2, 5.5	6.4, 7.3	4.3, 5.2	4.6-5.1	5.5	5.5, 6.9	4.4-7.4
12	1.6, 1.55	1.7	1.5, 1.5	1.6, 1.8	1.2, 1.3	1.3	1.5	1.4, 1.7	1.2-1.6
13	1.8, 1.8	1.6, 2.2	1.5, 1.6	1.8, 1.9	1.5, 1.7	1.6-1.8	1.6	1.7, 1.8	1.6-2.0
14	3.5, 3.5	4.2	4.0, 4.3	3.5, 3.9	4.4, 4.5	—	4.0, 4.3	4.3	3.0-4.2
15	9-12	6-8	7-9	7-10	7-10	6-8	8, 9	7-9	6-11
16	3.5, 3.8	4.1	3.75	3.8, 3.9	5.3, 5.9	4.3, 5.2	3.7, 4.3	4.6	2.8-4.2
17	9-12	6-9	7-9	7-9	7-9	6-8	7, 9	7-8	6-12
18	2.9	—	3.4, 3.4	3.1	3.6, 4.3	3.8, 4.4	4.1	4.1, 4.8	2.5-4.5
19	66	—	56, 70	68	61, 62	—	—	66, 67	19-69
20	3-4.5	3	3-4	1.5-3	3	3	3	3	1-3½
21	6-11	6-8	6-8	6-10	6-8	4-8	7	6	5-8
22	154	—	328	443	89	96, 105	119	1167	29-309
23	0.70-0.84	—	0.64-0.76	0.58-0.64	0.84-1.0	0.84-1.02	0.98-1.10	0.48-0.52	0.74-0.97

^AThere are some minor discrepancies between the putative paratype data derived by us and published data (Riek 1953).

Maxilliped 3. Endopod terminal segment 0·9–1·2 length of penultimate segment.

Branchial Formula. No variants were noted.

Peraeopod 1. Chelae 1·9–4·1 times as long as wide, 1·1–1·5 length of carpus; movable finger 0·4–0·6 length of propodus, and with 2–3 short terminal nails, fixed finger with 1–3 nails; carpus 1·6–2·7 as long as greatest width.

Peraeopod 2. Chelae 2·3–4·7 times as long as wide, 0·6–0·8 length of carpus; fingers 0·5–0·6 length of propodus; movable and fixed fingers with 1–3 terminal nails; carpus 4·4–7·4 as long as greatest width.

Peraeopod 3. Dactylus 0·25–0·33 length of propodus, with 6–11 spines on inner margin. Propodus 8·2–13·6 times as long as wide. Carpus 3·7–7·7 times as long as wide.

Peraeopod 4. Dactylus 0·24–0·36 length of propodus, with 6–12 spines on inner margin. Propodus 7·7–12·2 times as long as wide. Carpus 3·4–6·7 times as long as wide.

Peraeopod 5. Dactylus 0·2–0·4 length of propodus, with 19–69 spines on inner margin. Propodus 6·8–12·5 times as long as wide. Carpus 3·3–6·2 times as long as wide.

Pleopod 2 (♂). Appendix masculina with 1–9 spines.

Telson. Dorsal surface with up to 3½ pairs of strong marginal spines. Terminal setiferous spines 5–8.

Eggs. Total number of eggs on pleopods ranged from 29–309. Lengths and widths of eggs from 105 females ranged from 0·76 to 0·92 mm and 0·44 to 0·58 mm respectively and overall means (\pm s.d.) were 0·845 (\pm 0·035) mm and 0·513 (\pm 0·029) mm with coefficients of variation 4·2 and 5·6 respectively.

Geographical Variation

Geographical variation was investigated by comparing all available material (see Material Examined) with descriptions of the neotype and female topotype of *P. australiensis* as well as the description of conspecific material from Cardinia Creek, Victoria. The number of collections available was substantial and were from representative localities throughout the known distribution of *Paratya* in Australia. Meristic and non-meristic characters were examined. The meristic characters selected for examination were largely—though not entirely—characters regarded by previous authors as of diagnostic or descriptive value in atyid taxonomy (e.g. Kemp, 1917; Bouvier, 1925; Roux, 1926; Riek, 1953; Holthuis, 1960). The results of the investigations of meristic characters are summarized in Tables 2 and 3.

Despite the extensive distribution of *Paratya* in Australia, both the non-meristic and meristic investigations indicated the occurrence of only one species, *P. australiensis*. And, contrary to suggestions that regional races probably occur (Kemp 1917) and that morphological clines exist in Tasmania and perhaps on the mainland (Walker 1972), there was no indication of any regionally restricted or clearly identifiable race or subspecies, nor of clines in any morphological feature either in Tasmania or on the mainland. The characters claimed by Walker (1972) to exhibit geographical clines in Tasmania did not do so in our material (*viz.* rostrum length: width, dorsal and ventral rostral spines, propodus:dactylus length and dactyl spine number in peraeopods 3, 4 and 5).

Generally, the extent of geographical variation was within the known extent of morphological variation in the population of *P. australiensis* from Cardinia Creek,

Victoria. When this was not so (see Tables 2 and 3), differences, in any event, were not regarded as taxonomically significant in that they involved characters highly variable within the Cardinia Creek population. Particular note of mean egg length differences, however, is made. Although no regional trends or correlations with any morphological character were discovered, mean egg length did differ between localities and differences were sometimes statistically significant. Thus, in a comparison by *t*-test of mean egg length in females from four localities in southern Victoria collected November 1961, some of the differences of means between localities were significant (Table 4). Further, within a locality, egg length may be constant in time—as indicated by a comparison of mean egg length in the Cardinia Creek population of *P. australiensis* in samples collected October and November 1961 and 1962; in 1961, mean egg length was 0.848 mm in 40 females and in 1962 was 0.845 in 16 females, a non-significant difference. Factors influencing egg size differences between populations of *P. australiensis* remain unknown, but salinity has been suggested as one possible factor influencing atyid egg size. Whatever the factors, egg length in Australian populations of *Paratya* appears to have no taxonomic significance, a conclusion directly opposed to that of Riek (1953) on this matter.

Discussion of Synonymy

The status of Riek's (1953) taxonomic conclusions was investigated by examining material designated by him as paratype collections and material seen and named by him. All material is held by the Australian Museum, Sydney. Putative paratype collections examined by us were of *P. australiensis arrostra* (AM P13270), *P. atacta atacta* (P13279), *P. atacta adynata* (P13283) and *P. tasmaniensis* (P13273); named material was of *P. australiensis australiensis* (P7919, P13284), *P. australiensis arrostra* (P13261) and *P. atacta atacta* (P13281). In the examination, one large male and one large female were fully dissected from each putative paratype or named collection, and, if available, up to 8 other specimens were examined for characters discernible without dissection. Characters investigated were those specifically mentioned by Riek (1953) (Table 5). Results are tabulated in Table 6.

Comparison of variation shown in the data in Table 6 with the extent of variation known in a population of *P. australiensis* in Cardinia Creek, Victoria, leads us to conclude that there are no significant morphological differences in any of Riek's taxa from material regarded by us as conspecific with the neotype of *P. australiensis*. Riek's (1953) revision of Australian *Paratya* stressed egg size, rostral shape and peraeopod structure (especially that of the carpus of peraeopod 1) as features of taxonomic significance. None of these proved of any taxonomic use in our investigation of geographical variation of *Paratya* in Australia (see Tables 2 and 3); all were variable in a way uncorrelated with other morphological features or geography.

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