

A new shallow-water serolid (Isopoda: Flabellifera) from the Pacific coast of Panamá

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Introduction

In 1971 a serolid isopod was collected from near the mean low tide level on a sandy beach at Culebra Island, Panamá. Subsequent collecting has shown that this serolid occurs commonly on the shallow shelf in the vicinity of the Pacific entrance to the Panama Canal. Study of all material from this area indicates that the Panamanian serolid represents a new species of *Serolis*.

This finding is of particular interest for two reasons: (1) it represents the first documented case of a serolid species inhabiting the American tropics, and (2) the occurrence of the family in Panamá links zoogeographically the temperate, shelf-dwelling serolids (two species) in North America and the major centre of distribution of the Serolidae (37 shelf species) in the cool and cold waters of the southern hemisphere (Sheppard, 1933; Kussakin, 1973). *Serolis carinata* Lockington occurs in the northern hemisphere along the Pacific coasts of California and Baja California (Menzies & Barnard, 1959; Menzies, 1962 a), and *Serolis mgrayi* Menzies & Frankenberg is known in the Atlantic from the Georgia shelf. Recent collections from the Brazilian coast have shown some serolids to extend into subtropical waters (Bastida & Torti, 1970). On a global scale, the only other serolid known from the low latitudes is *Serolis yongei* Hale, which was collected at Low Isles, Great Barrier Reef, Australia, near 16°S (Sheppard, 1933). Off the Pacific coast of South America serolids have been taken from the central coast of Chile and possibly as far north as Callao, Peru (Menzies, 1962 b).

The objectives of this paper are to describe the Panamanian *Serolis*, examine its affinities with other members of the family, and provide information on the conditions of the warm-water environment which it inhabits. Hopefully this study will find some application in tracing the biogeographic and evolutionary relationships of this group.

Taxonomy

Family SEROLIDAE

Flabellifera with perconite 1 fused medially with cephalon, and tergum of pereonite 7 usually absent or, if present, incomplete. Pereopod 1 of both sexes and pereopod 2 of adult male with dactylus folding back upon greatly dilated propodus. Plp⁴ (pleopod 4) and Plp⁵ large, indurated and operculiform; Plp¹-Plp³ small; Plp² endopod of male bears long filamentous stylet (however, males of *Glabroserolis* Menzies, 1962, not yet examined). Last three abdominal somites fused with telson, forming large terminal pleotelson. Uropods small, normal, subapical, not arching over pleon. Body strongly depressed, flattened and usually broad (after Sheppard, 1933, and Menzies, 1962 b).

Genus *Serolis* Leach

Coxal plates of pereonites 2-4 separated by sutures. Uropoda biramous. Ant² (antenna 2) peduncular articles 4 and 5 elongate but not greatly expanded. Second article of Mxp (maxilliped) palp cordate, not quadrate (abbreviate and slightly modified after Menzies, 1962 c).

Serolis tropica sp. nov.

(figs. 1, 2 and 4)

Diagnosis: Uropod biramous. Articulating suture between pereon and pleonite 1 complete. First three free pereonites only with sutures separating coxal plates. Coxal plates of pereonite 6 extend posteriorly beyond pleonite 2 and 3. Pleonites 2 and 3 short, not extending posteriorly beyond anterior margin of pleotelson. Pleotelson with three dorsal carinae, mid carina extremely thin, lateral carinae weakly formed. Tergum with low relief mid-dorsal spines absent. Lateral margin of pereon smooth (not notched by differences in width of coxal plates), forming nearly continuous outline. Postero-lateral angles of free pereonites rounded, not acute. Lateral notch of pleotelson shallow, not forming distinct tooth. Postero-lateral angle of uropod

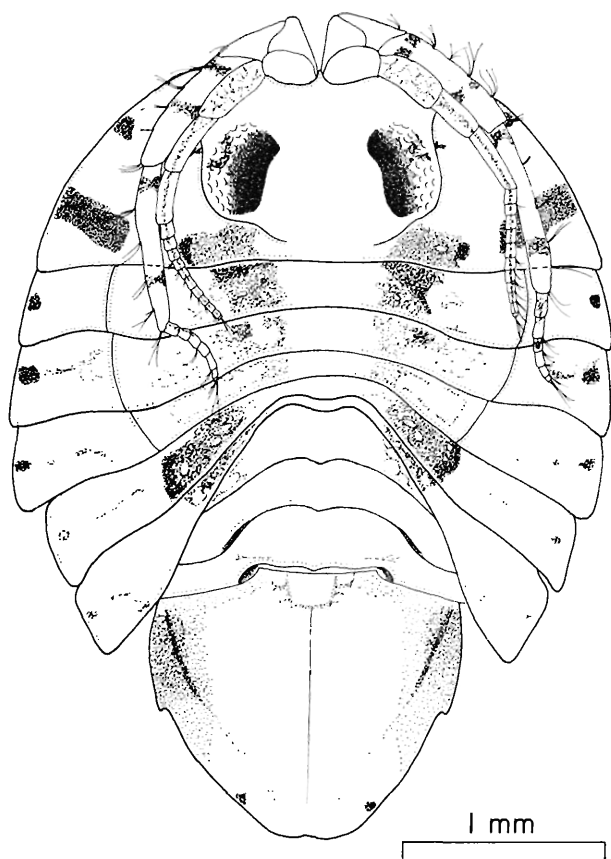


FIG. 1. *Serolis tropica* sp. nov., holotype, adult male, length 3.8 mm, width 2.9 mm.

basis obtuse. Median sternal spine of pleonite 1 short, not extending to base of sternal spine on pleonite 2. Peduncular articles of antennae stout.

Coloration: Holotype freshly preserved in formalin. Dark pigmentation on pereonites astride midline, converging medially toward posterior on pereonites 1-4 and diverging abruptly toward posterior on pereonites 5-6. Pigmentation on peduncular articles 4 and 5 of Ant² produces a banding appearance. Punctate pigmentation laterally on pereonites and with prominent pair of lateral markings on pereonite 1. Telson heavily pigmented along antero-lateral margins.

Measurements: Male holotype, length 3.8 mm (body length always measured from rostrum to posterior border of pleotelson), width 2.9 mm. Gravid female paratype (illustrated, fig. 2), length 4.2 mm, width 3.1 mm.

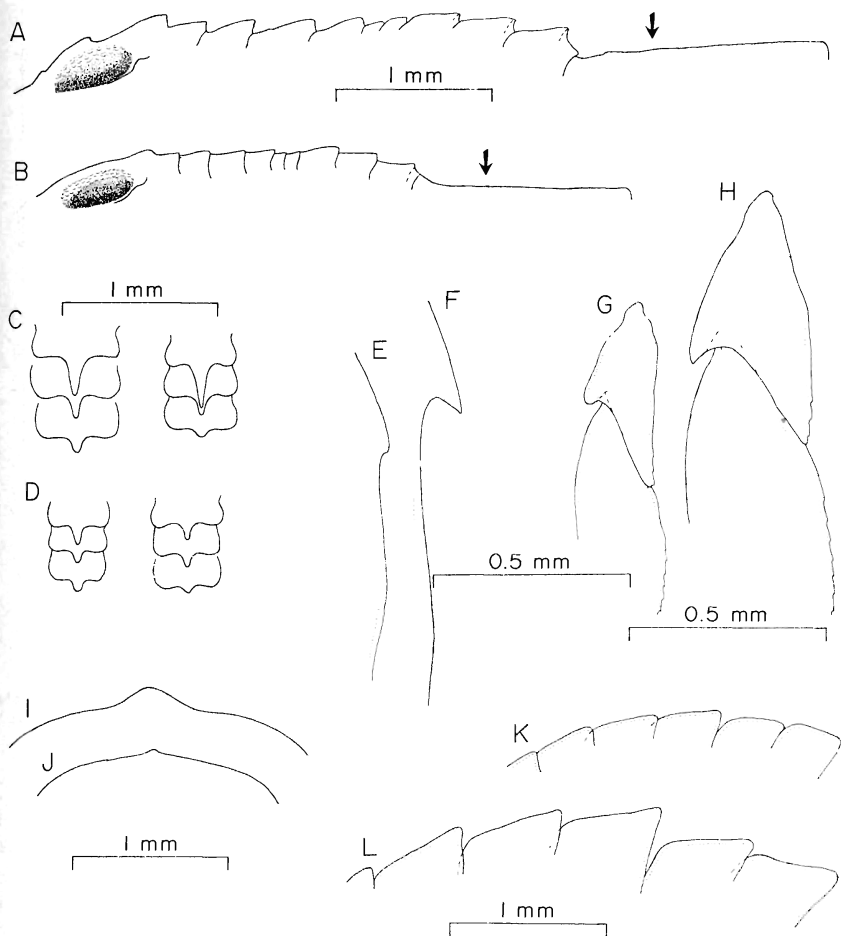


FIG. 2. *Serolis carinata* Lockington (A), (C), (F), (H), (I), (L) compared with *Serolis tropica* sp. nov. (B), (D), (E), (G), (J), (K). (A) and (B), profile of tergum. (C) and (D), ventral view of pleonites 1-3. (E) and (F), lateral margin of pleotelson. (G) and (H), basis of uropod. (I) and (J), cross-section through pleotelson at positions marked with arrows in (A) and (B). (K) and (L), lateral margin of pereon. Illustrations of *S. carinata* are of an adult male 5.2 mm in length except for sketch to right in (C) which is a 5.2 mm adult female. Illustrations of *S. tropica* are of holotype except for sketch to right in (D) which is a 4.2 mm gravid female paratype.

Type-locality: Between Tortola Island and Tortolita Island, Panamá Bay (8° 51' 50" N; 79° 33' 43" W; H. O. chart 5000, 19th ed.); NMNH-STRI Panamá Survey; Sta. 150-D. P; 19.v.1973; dredging on sand bottom with some broken shells, about 6.5 m depth; coll. J. N. A. Bryan, C. E. Dawson, M. L. Jones, K. F. Millard; holotype (USNM Cat. No. 150654).

Material examined: All type material of *Serolis tropica* sp. nov. (28 paratype) selected from Sta. 6b, see fig. 3, were deposited in the U.S. National Museum (USNM Cat. No. 150655), *Serolis myrayi*, male holotype (USNM Cat. No. 111071) Georgia shelf (31° 20' 22" N; 80° 00' 26" W), 40 m depth, coll. M. B. Gray, *Serolis carinata*, three specimens, San Diego Bay (Coronado Strand), California from -0.5 m tide level, coll. P. W. Glynn.

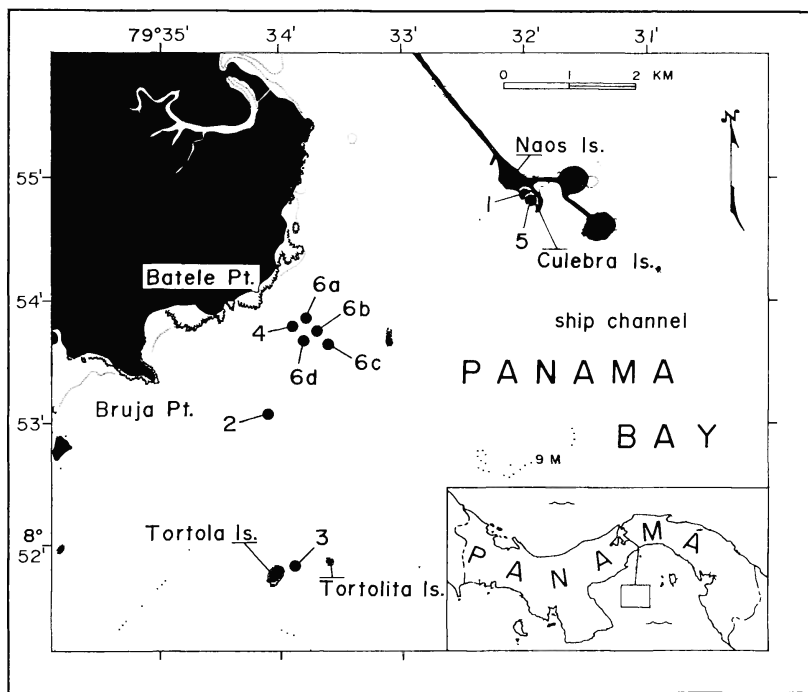


FIG. 3. Map of Pacific entrance to the Panama Canal showing locations of collecting stations (1-6d). Station 3 is the type-locality of *Serolis tropica*.

Range: Eastern Pacific in vicinity of Panama Canal.

Local distribution: Shallow shelf and low intertidal zone in vicinity of Pacific entrance to the Panama Canal. The following stations are listed chronologically and their location in Panamá Bay is indicated in fig. 3 (1) Culebra Island sand beach: intertidal zone near mean low water level; 1971 month unknown: sifting beach sand (mesh size of screen approximately 1 mm) for sphaeromatid isopods (*Ancinuss*); coll. C. S. Glynn and A. Velarde; 1 specimen. (2) Southeast of Bruja Point: NMNH-STRI Panamá Survey; Sta. 150-B. P; 19.v.1973; dredging with epibenthic sled (mesh size 158 μ) on sand and broken *Pecten* shell bottom; about 4.5 m depth; coll. J. N. A. Bryan, C. E. Dawson, M. L. Jones, K. F. Millard; 1 specimen. (3) Type-locality (see above). (4) Southeast of Batele Point; NMNH-STRI Panamá Survey; Sta.

161-2, P; 9.xi.1973; dredging with epibenthic sled (mesh size $158\ \mu$) on sand and shell bottom, about 2 m depth; coll. C. E. Dawson, M. L. Jones, A. Rodaniche; 2 specimens. (5) Culebra Island sand beach; intertidal zone near mean lower low water level; 8.iii.1974; beach sand sampled quantitatively with $500\ \mu$ net and by flotation with saturated sugar solution; coll. D. Dexter; 2 specimens. (6) Southeast of Batele Point; dredging with epibenthic sled (mesh size $500\ \mu$) on sand and shell bottom; 25.iii.1974; coll. L. G. Abele, P. W. Glynn, F. Crastz, V. Martínez; Sta. 6a, 1.5 m depth, 24 individuals with estimated density of 2.2 individuals/ m^2 ; Sta. 6b, 3 m depth, 32 individuals with estimated density of 2.9 individuals/ m^2 ; Sta. 6c, 4 m depth, 38 individuals with estimated density of 3.5 individuals/ m^2 ; Sta. 6d, 3 m depth, 24 individuals with estimated density of 2.2 individuals/ m^2 . Also collected at Farfán flat (outside of area illustrated in fig. 3), SW bank of Panama Canal ($8^\circ\ 56.4' N$; $79^\circ\ 34.2' W$); NMNH-STRI Panamá Survey; Sta. 185-C, P; 12.iii.1974; sifting muddy sand beach sediment (mesh size of screen 1 mm); -0.4 m depth; coll. M. L. Jones, H. W. Kaufman; 1 gravid female.

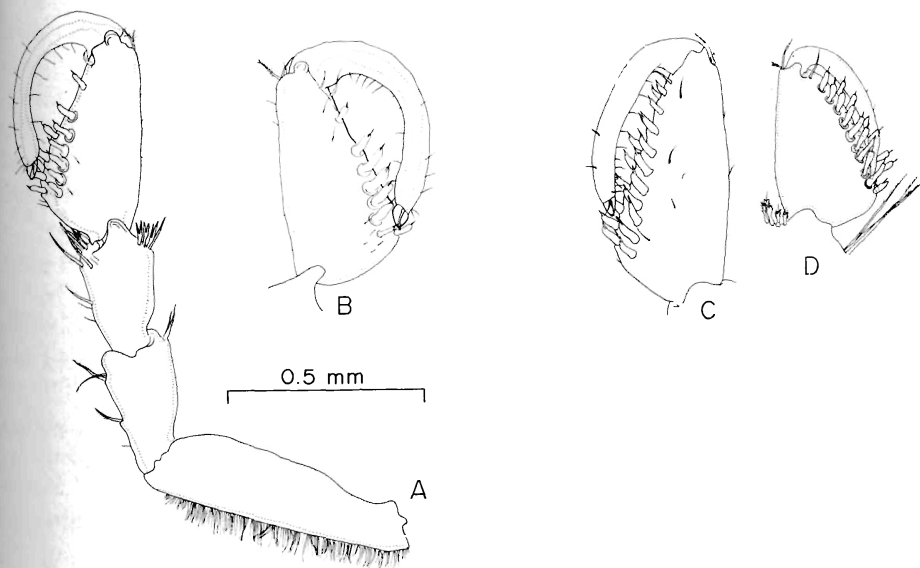


FIG. 4. Lateral views of male pereopod 2. *Serolis tropica* sp. nov., paratypes, drawn to scale (A), (B); (A) from 5.2 mm specimen, basis omitted, (B) view of propodus and dactylus, from 5.6 mm specimen. *Serolis carinata* Loekington (C), view of propodus and dactylus, adult specimen (after Hessler, 1972). *Serolis mgrayi* Menzies & Frankenberg (D), view of propodus and dactylus, from 4.0 mm specimen (after Menzies & Frankenberg, 1966, setae on palm of propodus redrawn). (C) and (D) not drawn to scale.

Supplementary descriptive notes: Collection No. 6c, 36 paratypes; 2 largest males, 6.4×5.2 mm and 5.9×4.8 mm (length \times width); 2 largest females (non-gravid), 4.2×3.3 mm and 2.8×2.2 mm; mean sample length 2.09 mm, $s_x = 0.20$. The largest female (gravid) paratype collected was 5.3×3.8 mm. The following ratios of body length to width were calculated for six specimens of each species. *Serolis tropica* (4.1–5.9 mm length): 1.23, 1.24, 1.29, 1.30, 1.35, 1.38. *Serolis carinata* (5.2–8.0 mm): 1.14*, 1.15, 1.20, 1.23*, 1.24, 1.29* (*=from published data). The Mann-Whitney U test shows a significant

difference ($p \sim 0.01$), indicating that *S. tropica* is relatively narrower than *S. carinata*.

Hessler's (1972) measurements of the length and width of limb segments indicate that these are stouter in *Serolis mgrayi* than in *S. carinata* (comparisons in first two rows in the table). New data are presented in the table for an additional individual of *S. carinata* and for four individuals of *S. tropica*. Most of the limb segments in the newly examined male of *S. carinata* (only one specimen was available for study) were stouter than those in *S. mgrayi*. This suggests a far greater range of intraspecific variation in limb segments than that found by Hessler (*op. cit.*). Of course, the possibility that these results are due to differences in measuring technique can not be ruled out. A consistent trend can be seen, however, in the size differences of the antennal segments. In every case the length-width ratios were lowest in *S. tropica*, a reflection of the relatively stoutly formed antennae in this species. The length-width ratios of the pereopods of *S. tropica* do not appear to differ significantly from the broadly overlapping values in *S. mgrayi* and *S. carinata*.

Comparative data on the length-width ratio of limb segments in adult males of *Serolis mgrayi*, *S. carinata*, and *S. tropica* sp. nov.

	Ant ¹		Ant ²		Per. I		Per. II				Per. VI			
	seg. 2	seg. 3	seg. 4	isch.	pro.	isch.	mer.	car.	pro.	isch.	mer.	car.	pro.	
<i>S. mgrayi</i>	2.4 ^a	4.4	9.4	2.4	2.2	3.6	1.9	1.7	1.7	4.4	2.6	5.0	6.7	
<i>S. carinata</i>	2.5 ^a	5.3	10.7	2.7	2.2	4.0	2.1	1.9	2.3	4.5	2.8	5.3	7.4	
	2.5 ^b	4.4	8.8	3.1	2.1	3.0	1.9	1.4	2.1	3.8	2.5	4.4	6.6	
<i>S. tropica</i>	2.2 ^c	4.0	7.5	2.6	2.0	3.3	2.1	2.0	2.1	4.1	2.7	4.5	6.2	
	2.2 ^d	4.1	7.2	2.8	2.2	3.1	1.7	1.2	2.0	4.0	2.2	4.3	5.2	
	2.2 ^e	4.0	7.4	2.8	2.2	3.3	1.7	1.4	2.0	3.6	2.2	5.0	6.4	
	1.9 ^f	3.9	7.3	3.1	2.2	3.2	1.4	1.8	1.8	3.8	2.2	5.1	6.9	

(a) After Hessler (1972), body length (rostrum to pleotelson) of holotype of *S. mgrayi* 4.1 mm; range of body lengths in *S. carinata* 5.3-6.4 mm (the number of individuals measured was not specified).

(b) Collected by author in San Diego Bay, California, length 5.0 mm. The entries for the specimen and all individuals of *S. tropica* are averages of measurements from both limbs.

(c) Paratype, length 3.2 mm.

(d) Holotype, length 3.8 mm.

(e) Paratype, length 6.0 mm.

(f) Paratype, length 6.3 mm.

Relief of tergum more pronounced in largest individuals (≥ 6 mm) but cephalic spines always absent. In some of largest individuals the lateral notch on the pleotelson and the postero-lateral angle of the uropod basis have acute margins.

P² (pereopod 2) ischium ventral margin (facing forward) with dense setal fringe in three largest (≥ 5.9 mm) male paratypes (fig. 4); small adult male (up to ~ 4 mm), including holotype, and adult females (up to 5.5 mm) without setal fringe. The dense setal border is also absent from adult male (one individual) and female (two individuals) specimens of *Serolis carinata* (5.2 to 5.3 mm) and from large specimens of *S. carinata*, up to 6.4 mm, and *S. mgrayi* as well (Hessler, 1972). As in *S. carinata*, the ventral margin of the merus of P² in *S. tropica* bears setae both distally and midway. P² dactylus highly arched in large (≥ 5 mm) individuals of *S. tropica*. In addition, fewer spine

or basic ventral setae are present on the palm of propodus of P² in *S. tropica* (total of 11 spines) than in *S. carinata* or *S. mgrayi* (total of 16-18 spines) (fig. 4).

Mx² (maxilla 2) lobes bear 2 setae each. Mxp basis antero-lateral corner not highly angular as in *S. carinata* or rounded as in *S. mgrayi*, but rather intermediate in form.

In *S. tropica* the stylet ranges from 3.2-4.2 × the length of the endopod in males 3.5-3.8 mm in body length. In larger males (5.0-5.5 mm) the stylet ranges from 5.6-5.9 × the length of the endopod, indicating that the smaller males are probably referable to developmental stage 3 (subadults) and the larger males to the adult stage 4 (Hessler, 1967, compare figs. (3 i) and (j)). In *S. carinata* and *S. mgrayi* the stylet is 5.9 × and 8.2 × the length of the endopod respectively in specimens illustrated by Hessler (1972) and Menzies & Frankenberg (1966). The possibility that the long stylet in adult *S. mgrayi* represents a valid difference should be investigated when more material becomes available.

Pigmentation pattern of holotype also observed in several adult paratypes with only minor variations. Additionally, the following colour patterns were noted in freshly collected animals: (a) body uniformly tan, (b) tan with mid-dorsal brown stripe extending along full length of body, (c) grey with white body margins, (d) lilac grey with mid-dorsal white stripe along full body length, and (e) nearly translucent (colours according to Kornerup & Wanscher, 1967).

In summary, the following characters of *S. tropica* readily separate it from *S. carinata* and *S. mgrayi*: (1) tergum of low relief and lacking mid-dorsal cephalic spines, (2) lateral margin of pereon smooth in outline, (3) sternal spine on pleonite 1 short, not reaching to base of spine on pleonite 2, and (4) P² in large adult males with dense setal fringe on ischium, with highly arched dactylus, and with relatively few spines on palm of propodus. The various distinguishing characters observed in this study, and their demonstrated reliability, substantiate the recognition of two north temperate shelf serolids (contr. Menzies *et al.*, 1973) and a new tropical species in the northern hemisphere. These species will henceforth be referred to as the 'carinata' group.

Sex ratio and breeding condition: From a pooled sample (Palo Seco collections, 25.iii.1974) of 12 individuals over 2.5 mm in length (it is suspected that smaller individuals are immature), nine were females. Four of the nine females contained eggs or embryos in an advanced (pre-juvenile) stage of development. The mean number of brood was 20 and the range 13-25. These observations were made toward the end of the dry season when seawater temperatures were in the range of 26°-27°C.

A second large collection was made off Palo Seco on 5.viii.1974 (stations 6b-6d were resampled), at the height of the wet season when seawater temperatures are higher (~28°C). Of the 35 adults collected, 14 were males and 21 were females. Sixteen of the females, or 76.2% of those over 2.5 mm in size, were gravid.

Affinities: The members of the 'carinata' species group (*S. carinata*, *S. mgrayi*, and *S. tropica*) are very closely allied. The morphological differences

examined show a more or less equal degree of divergence among the three species.

The 'marplatensis' group of South America (*S. convexa* Cunningham & *S. plana* Dana†), *S. gualichaudii* Audouin & Milne Edwards, *S. laevis* Richardson and *S. marplatensis* Bastida & Torti) demonstrates perhaps the closest relationship to the 'carinata' group. The unique set of features distinguishing the 'marplatensis' group (Bastida & Torti, 1970) are, however, only partly shared by the 'carinata' group. The essential features of the pereonite pleonites and pleotelson occur in both groups. All members of the 'carinata' group can be distinguished from the 'marplatensis' group as follows: (1) Mx lobes bear only two setae each; the lobes in 'marplatensis' species bear numerous setae (around seven). (2) setae on ventral margin of propodus (P¹) identical in both sexes; the setae differ among males and females in the 'marplatensis' group. (3) carpus of P¹ in males nearly naked, without a dense cluster of plumose setae; 'marplatensis' males possess the cluster of setae. (4) articles 4-6 of P⁷ without plumose setae in both sexes; the setae are present in 'marplatensis' males.

Etymology: The specific epithet, derived from *tropikos* (Gr.), denotes the low latitudinal occurrence of this species.

Discussion

Serolis tropica lives under warm-water conditions (mean sea surface temperature = 28°C, range 24-32°C, Glynn, 1972) during the wet season (June-November) and is subject to cooler conditions (mean = 24°C, range 16°-29°C) in the dry season (January-April). The salinity regime shows an approximate inverse seasonal pattern to that of temperature—in the wet season mean salinities are often around 28 o/oo (range 22-31 o/oo) and in the dry season 35 o/oo (range 33-36 o/oo). During a period of upwelling, which lasted for 3 days, *S. tropica* was collected from the Naos Island sand beach. The serolid was never observed intertidally in the wet season or during non-upwelling periods in the dry season, despite extensive sampling in this habitat (Dexter, pers. comm., Glynn & Glynn, unpub. data). Other crustaceans not previously collected from the shore—for example, cumaceans and munnid isopods (on the beach, Dexter, personal communication) and hippolytid shrimp (in rock pools, Abele, personal communication)—also moved into the intertidal zone during upwelling. The seawater temperature dropped 4°-5°C, to about 21°C, on this particular occasion. Serolid and munnid isopods were not found on the beach 2 days following the cool-water period, and the cumaceans had diminished considerably in numbers. Thus, it appears that the occurrence of *S. tropica* (and probably some other crustaceans) in the intertidal zone is ephemeral and related to the change in conditions accompanying upwelling.

Since reproductive females were found with brood in both the wet and dry seasons, it would seem that *S. tropica* is well adapted to the warm hydrographic climate which prevails most of the year. This species, then, provides an exception to the antitropical character of the genus (Menzies, 1962 b).

The closest relatives of the 'carinata' group appear to belong to the 'marplatensis' group, whose members inhabit cold temperate to subpolar

† *Serolis convexa* and *S. plana* may be identical; this problem is still unresolved (Bastida & Torti, 1970).

water off South America and the South Sandwich Islands. *Serolis gaudichaudii* ranges as far north as 38° 22' S off the Pacific coast of Chile and *S. gaudichaudii* and *S. marplatensis* have been collected between 34° and 38° S on the shelf off Argentina and Uruguay. Two, more distantly related species of *Serolis* have been collected as far north as Rio de Janeiro (between 22°–24° S), at the boundary of warm temperate and subtropical regions. All members of the 'marplatensis' group have a narrow and shallow bathymetric distribution: they occur to a maximum depth of less than 200 m. The maximum recorded depth in the 'carinata' group is 55 m.

It seems reasonable to conclude that the 'marplatensis' group is related to the ancestral stock which gave rise to serolids that moved into the shelf waters of the northern hemisphere. The presence of *S. tropica* in a shallow tropical shelf environment indicates that the northerly spread of *Serolis* need not have required submergence across the low latitudes as formerly postulated (Ekman, 1953).

Summary

The discovery of *Serolis tropica* sp. nov. in the shallow shelf zone of the Pacific of Panamá, just south of 9°N latitude, establishes the first occurrence of the Serolidae in tropical American waters. Since gravid females were found in cool as well as warm thermal seasons, it is assumed that this species is adapted to live under tropical conditions. *Serolis yongei*, known from the Great Barrier Reef, was collected at a depth of 200 m. It is not presently known if this species, like *S. tropica*, also inhabits the shallow shelf where warm-water conditions prevail.

Serolis tropica, a member of the North American 'carinata' group, is related to the 'marplatensis' group of South America. While it is argued that these two groups must have shared a common history, the remaining region of approximately 40° latitude between the northern and southern forms greatly complicates the relationship. Whether or not this gap is real or due to a lack of fine, inshore sampling can only be determined by further field work in this region.

Resumen

El descubrimiento de *Serolis tropica* sp. nov. en la zona llana de la plataforma continental en el Océano Pacífico de Panamá, solo al sur de la latitud 9°N, establece la primera aparición de la Serolidae en aguas tropicales americanas. Ya que hembras preñadas fueron encontradas en aguas frescas (debido al afloramiento) y en estaciones en las cuales el agua está tibia, es de asumir que esta especie está adaptada a vivir bajo condiciones tropicales. *Serolis yongei*, conocida de la Barrera de Coral en Australia, fue colectada a una profundidad de 200 m. No es conocido si esta especie, como *S. tropica*, también habita la plataforma llana donde las aguas tibias prevalecen.

Serolis tropica, un miembro del grupo 'carinata' de Norte América, está relacionado con el grupo 'marplatensis' de Sur América. Mientras se discute que estos dos grupos deben haber compartido una historia común, la región que queda de aproximadamente 40° latitud entre las formas del norte y del sur complica grandemente la relación entre ambos grupos. No se sabe si la

ausencia de este grupo se debe a la falta de colecciones en el literal de esta región; se necesita conseguir más muestras para determinar este hecho.

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References

- BASTIDA, R. & TORTI, M. R. 1970. Crustáceos isópodos: Serolidae. Résultats Scientifiques des Campagnes de la *Calypso*. *Ann. Inst. Océan.* **47** (9) : 61-105.
- EKMAN, S. 1953. *Zoogeography of the Sea*. p. 417. Sidgwick & Jackson, London.
- GLYNN, P. W. 1972. Observations on the ecology of the Caribbean and Pacific coasts of Panamá. In: *The Panamian biota: some observations prior to a sea-level canal*. Edited by Jones, M. L., *Bull. Biol. Soc. Washington* **2** (8) : 13-30.
- HESSLER, R. R. 1967. A record of Serolidae (Isopoda) from the North Atlantic Ocean. *Crustaceana* **12** (2) : 159-162.
- 1972. The relationship between *Serolis carinata* Lockington and *Serolis nuyagi* Menzies Frankenberg (Isopoda, Flabellifera). *Crustaceana*, suppl. **3** : 1-6.
- KORNERUP, A. & WANSCHER, J. H. 1967. *Methuen Handbook of Colour*. p. 243. Methuen, London.
- KUSSAKIN, O. G. 1973. Peculiarities of the geographical and vertical distribution of marine isopods and the problem of deep-sea fauna origin. *Mar. Biol.* **23** (1) : 19-34.
- MENZIES, R. J. 1962 a. The marine isopod fauna of Bahía de San Quintín, Baja California, México. *Pac. Nat.* **3** (11) : 337-348.
- 1962 b. The zoogeography, ecology, and systematics of the Chilean marine isopods. Repts. Lund Univ. Chile Exped. 1948-49, 42. *Lund Univ. Årsskrift, N. F. Afd.* **57** (11) : 1-162.
- 1962 c. The isopods of abyssal depths in the Atlantic Ocean. *Fema Res. Ser.* (1) : 79-26.
- MENZIES, R. J. & BARNARD, J. L. 1959. Marine Isopoda on coastal shelf bottoms of Southern California: systematics and ecology. *Pac. Nat.* **1** (11) : 3-35.
- MENZIES, R. J. & FRANKENBERG, D. 1966. *Handbook on the Common Marine Isopod Crustacea of Georgia*. p. 93. Univ. Georgia Press, Athens.
- MENZIES, R. J., GEORGE, R. Y. & ROWE, G. T. 1973. *Abyssal Environment and Ecology of the World Oceans*. p. 488. John Wiley, New York.
- SHEPPARD, E. M. 1933. Isopod Crustacea, Part 1. The family Serolidae. *Discovery Rep.* **7** : 253-362.