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The Species of Sand Crabs in the Genus *Lepidopa* (Decadopa: Albuneidae)

By

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With 12 Figures

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This paper contains a review of the species in the genus *Lepidopa* and descriptions of six new species. The evolutionary relationship between the species is discussed with particular reference to geographical distribution and to the closure of the sea connection across Central America in the late Pliocene.

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Holthuis (1961, 1962) has recently reviewed the eighteenth and early nineteenth century literature dealing with the genus *Lepidopa* and he concluded that Fabricius (1793) and Desmarest (1825) in their descriptions of *Albunea scutellata* were dealing with the brachyuran crab, *Thia scutellata* and not with a species that other authors have assigned to the genus *Lepidopa*. Thus the first published description of a crab that can definitely be assigned to the genus *Lepidopa* is H. Milne Edwards' (1837) description of *Albunea scutellata*. Holthuis (1961) suggested that this was probably a specimen of *Lepidopa richmondi* but recently I examined an individual of *Lepidopa benedicti* in the Paris Museum that is probably Milne Edwards' original specimen. The label reads '*Lepidopa scutellata* type?' and, according to Dr. J. Forest, was written by Bouvier: however, the specimen is much older than this label and agrees closely with Milne Edwards' original figure.

Stimpson (1858) was the first to use the name *Lepidopa* and he described the first species, *Lepidopa venusta*, in 1859. Holthuis (1962) designated this species as the type of the genus (see also Chace and Haig 1962), and subsequently his views were accepted and the generic name *Lepidopa* appeared in the official list of generic names (Opinion 693; Bull. Zool. Nom. 1964, 21: 28).

In the following account initials for the various collections are used. These are USNM — United States National Museum, Washington; RMNH — Rijksmuseum van Natuurlijke Historie, Leiden; MCZ — Museum of Comparative Zoology, Harvard University, Cambridge; ZMK — Universitetets Zoologiske Museum, Copenhagen; AHF — Allan Hancock Foundation, University of Southern California, Los Angeles; AMNH — American Museum of Natural History, New York; BMNH — British Museum (Natural History), London; TU — Tulane University Collection, New Orleans; MNHN — Museum National d'Histoire Naturelle, Paris; BLY — Bingham Laboratories, Yale University, New Haven; PANS — Philadelphia Academy of Natural Sciences, Philadelphia; HEE — material in my own collection. Whenever possible the number of the collection is given. If there is no number then the accession number, the collector, the date, the station number and boat or some other reference is given to identify the material being discussed.

Two other abbreviations are used; cl. — carapace length and cw. — carapace width. In addition the word "part" is included in the references. This means that only some of the material referred to in the reference can be assigned to the species being discussed. It should be clear from the context which is which.

Lepidopa Stimpson 1858

Stimpson, 1858, Proc. Acad. Natur. Sci. Philadelphia: 230; Miers, 1878, J. Linn. Soc., London, Zool., 14: 331 (as *Lepidops*); Holmes, 1900, Occas. Pap. Calif. Acad. Sci., 7: 105; Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 891; Porter, 1915, Bol. Mus. Natl. Chile, 8: 17; Schmitt, 1921, Univ. Calif. Publ. Zool., 23: 172; Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 188; Mendes, 1945, Arq. Mus. Paranaense, 4: 119; Holthuis, 1961, Proc. K. Nederland Akad. Wet., Ser. C, 64: 27; Holthuis, 1962, Bull. Zool. Nomen., 19 (4): 125; Clarke, 1962, Crustaceana, 2: 251.

Diagnostic Characters: Carapace squarish, anterior margin with median triangular or rounded rostrum flanked by ocular sinus, these sinuses flanked by two anteriolateral lobes, each terminating in distinct spine (except in *Lepidopa haigae* sp. nov.); anterior corners of carapace with spine lying above linea anomurica; edge of anterior margin often completely or partly lined with small teeth and usually lined with long setae but without row of short spines found in many *Albunea;* posterior part broadly truncated, deeply concave in center; colour of carapace generally iridescent white or chalky white, convex from side to side while flat when viewed laterally.

First abdominal somite quite large, about as long as broad, narrowing towards anterior edge; pleural expansion on second abdominal segment very large; pleural expansion present on third, fourth and fifth segments; expansion on fifth abdominal segment separating the genus from *Albunea*, *Zygopa* and *Stemonopa* where this expansion is lacking.

Antennules very long, always longer than carapace, with two flagella, one very long and one very short. Antennae with short scaphocerite; flagellum usually with eight (range 7—11) articles.

Eyes on separate, lamelliform eye-plates that almost touch; upper surface of plate smooth and shiny, setae around edge only, in contrast with *Leucolepidopa*, where plate is setose on upper surface; presence of eye pigment very variable. I believe that this is because young animals always have pigment but in many species this is lost with age and in addition it sometimes disappears with preservation.

Mandibular palp three-segmented. Second maxilliped with two-segmented exopod. Basi-ischium of third maxilliped unarmed, carpus strongly produced anterio-dorsally, reaching more than half way to distal end of propodus; exopod of third maxilliped a single slender article.

First pereopod sub-chelate, fifth chelate; dactyla of second to fourth pereopods are flattened sickle-shaped digging segments. Pleopods of large females of egg laying size very long but frequently reduced in smaller females. Pleopods very small in some males, which, when known, are usually much smaller than the females; furthermore, some specimens have both male and female genital pores open at the same time and these specimens carry small pleopods. This suggests that protandry occurs.

The genus is known only from along the coast of the Americas and the associated off-shore islands, particularly in the Caribbean and the Galapagos.

A key separating *Lepidopa* from other genera in the Family Albuneidae is given elsewhere (Efford and Haig 1968). Below is a key to separate the species of *Lepidopa* and an account of their distribution and the distinctive characters of each species.

Key to the genus *Lepidopa*

1 a Eye-plates squarish, distal edge carrying teeth and lined with long setae, eye-spot usually present and situated on lateral edge of eye-plate (Fig. 3 a—g); ventral surface of plate usually smooth and setae if present, near edges (Fig. 3 h, i). Carpus of third maxilliped extended but not reaching to distal end of propodus (Fig. 4 e). Subrostral spine sometimes present. Groove along posterior edge of carapace extending forward along edge of medial concavity so that it reaches beyond anterior edge of concavity; sometimes it runs parallel with the edge (Fig. 2). Antenna with eight articles ..... *benedicti* group 2

1 b Distal edge of eye-plate roundish and smooth or lined with short setae arising from underside of plate 7

2 a subrostral spine present 3

2 b subrostral spine absent 5

3 a Groove around posterior edge of carapace interrupted medially (Fig. 2 b, c, d) 4

3 b Groove around posterior edge of carapace continuous without interruption and carrying a few setae (Fig. 2 a) ..... *richmondi*

4 a Anteriolateral lobe on anterior edge of carapace truncated and lacking spines (Fig. 2 e) ..... *haigae*

4 b Anteriolateral lobes triangular and carrying distinct spines (Fig. 2 b) ..... *mearnsi*

5 a Distal edge of eye-plate extended laterally over eye-spot in larger animals; ventral side with row of long setae running parallel to setae lining distal edge of plate (Fig. 3 c, g, i) ..... *deamae*

5 b Distal edge of plate not extended over eye; at most a few scattered setae on ventral surface of plate and no long rows lining distal edge behind row on edge itself 6

6 a Ventral side of eye-plate without setae except around the actual edge; many teeth lining distal edge of plate (20 or more in large individuals), the teeth close together, almost touching (Fig. 3 a) ..... *benedicti*

6 b Ventral side of eye-plate carrying a short row of setae just distal to eye-spot; teeth lining distal end of plate few (about 10) and well spaced, not nearly touching (Fig. 3 f, h) ..... *sorodeamae*

7 a Eye-plate longer than broad with sides relatively straight, eye-spot terminal (Fig. 3 n—s); distal edge of eye-plate rounded and smooth. No rostral spine present and rostrum broadly rounded. Antennal flagellum with seven or eight articles. Includes all specimens with carpus of third maxilliped longer than propodus (Fig. 4 d) and one species where it is shorter (Fig. 4 b) ..... *californica* and *myops* group.... 8

7 b Eye-plates roundish with distal end usually narrow, eye-spot terminal if present (Fig. 3 p); distal edge of eye-plate usually smooth, lined with relatively short setae arising on ventral side of plate rather than along the actual edge; ventral side of plate with mat of long setae covering much of distal half. Subrostral spine always present. Carpus of third maxilliped overlapping propodus but not reaching to distal end. Groove around posterior edge of carapace stopping at medial concavity and not following edge of concavity (Fig. 2 j). Antenna with eight articles in flagellum .. .. *venusta* group 11

8 a Carpus of third maxilliped extending clear over propodus and overlapping dactylus (Fig. 4 d, f). Groove around posterior edge of carapace extending half way up side of medial concavity (Fig. 2 f, g). Eye-plate lacking long setae around edge. Distinct setal pattern on carapace behind central line (Fig. 4 p). Anterior edge of the carapace with noticeable teeth, some longer than broad. Antenna with seven articles in flagellum ..... *myops* group 9

8 b Carpus of third maxilliped extending over propodus but not reaching to distal end (Fig. 4 b). Groove around posterior edge of carapace running parallel with edge but stopping at medial concavity (Fig. 2 i). Eye-plates with a few short setae down outside edge of plate (Fig. 3 m). Anterior edge of carapace with small, short, rounded teeth ..... *californica*

9 a Eye-plates not narrowing at distal end but truncated with rounded corners 10

9 b Eye-plates clearly narrow towards distal end (Fig. 3 k) ..... *distincta*

10 a Line of setae running backwards from lateral spine straight and unbroken (Fig. 4 u) ..... *myops*

10 b Line of setae running backwards from lateral spine broken into small groups especially near posterior end (Fig. 4 v) ..... *panamaensis*

11 a Eye-plate as wide as long or almost so 15

11 b Eye-plate longer than wide. Propodus not greatly expanded at anteriodorsal region 12

12 a Emargination in anterior edge of second abdominal segment no more in width than length of segment along central line 13

12 b Emargination in anterior edge of second segment wider than segment is long at central line 14

13 a Rostrum long, extending forward level with base of anteriolateral spines. Emargi-

nation in second segment about two-thirds as wide as segment at central line (Fig. 2 j). Atlantic and Caribbean ..... *websteri*

13 b Rostrum short, only extending forward to just over half way up side of ocular sinus. Emargination in second abdominal segment wider than in *websteri* and almost equal to width of segment in central line (Fig. 2 i) ..... *esposa*

14 a Anterior edge of second segment's pleural expansions sloping backwards towards lateral edge. Bulge in between ocular sinus and anteriolateral lobes quite clear. Eye-plate with slight notch in distal end (Fig. 3 p) Caribbean ..... *venusta*

14 b Anterior edge of pleural expansion of second abdominal segment almost straight or with a very slight backward slant. Bulge between ocular sinus and anteriolateral lobe very small, edge almost straight (Fig. 2 k). No notch in distal end of eye-plate (Fig. 3 s). Pacific Coast ..... *mexicana*

15 a Eye-plate almost round (Fig. 3 n, o). Propodus expanded at anteriodorsal area and overlapping dactylus (Fig. 4 i) ..... *chilensis*

15 b Eye-plate not quite as wide as long (Fig. 8 a). Propodus only slightly expanded to overlap dactylus (Fig. 4 n). Concavity in anterior edge of second abdominal segment has sloping sides (Fig. 1 h) ..... *wollebaeki*

Lepidopa myops Stimpson

(Fig. 1 e, p; Fig. 2 f; Fig. 3 j; Fig. 4 d, u; Fig. 5 q; Fig. 6 a, d; Fig. 7 e)

Lepidopa myops Stimpson, 1860, Ann. Lyc. Natur. Hist. New York, 7: 241; Miers, 1878, Linn. Soc. London, Zool., 14: 333, pl. 14, fig. 16; Ortmann, 1896, Zool. Jahrb. Abt. Syst., 9 (2): 226; Holmes, 1900, Occas. Pap. Calif. Acad. Sci., 7: 105 (part); Rathbun, 1904, Harriman's Alaska Series (Crustaceans, 10): 167 (part); Schmitt, 1921, Univ. Calif. Publ. Zool., 23: 172 (part); Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 118 (part).

Types: Stimpson did not designate a holotype. Schmitt (1921) mentioned a type female and gave its measurements but it seems probable that he was quoting the measurements of a single female that Stimpson gave in his original description (W. O. Schmitt, personal communication). Three collections exist that were part of the original J. Xantus collection and are therefore syntypes. The one in the BMNH (61.44) is labelled 'syntype' and is listed by Evans (1967) as part of the original Stimpson material, another is in the MNHN (4.99) and the third is in the MCZ (1386). I have selected the specimen in the MCZ, which is an ovigerous female cl. 9 mm cw. 11 mm, as the lectotype of this species so that the specimens in the other two collections become paralectotypes. There is another collection, PANS 947, which is probably also from the original collection. It was given to the Academy by the USNM but the actual locality from which the material came is not known and the USNM does not have any material of this species at the present time. Presumably Stimpson took the original material to Chicago with him and it was lost in the fire.

Distribution: This species has only been recorded from the immediate vicinity of Cape San Lucas, Baja California, Mexico — the type locality. Since the beginning of the century (Holmes 1900) it has been confused with *Lepidopa california* sp. nov. which is found along the coast of California from San Pedro to the Mexican border and in the head of the gulf.

Mexico: Cape San Lucas, Baja California (type locality; Gordon 1938: 188; MCZ 1386; BMNH 61.44; MNHN 4.99; AHF Velero III 1724–49 and a second collection); Santa Maria Bay, Baja California (AHF Velero III 1031–40).

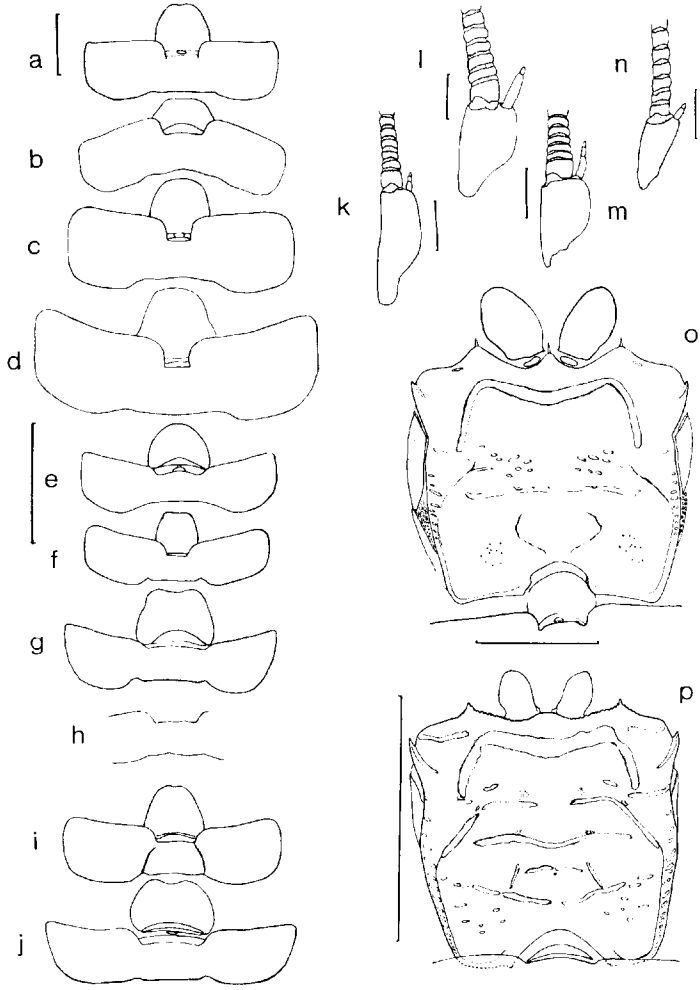

Fig. 1. *Lepidopa*. Dorsal view of first and second abdominal segments. a) *benedicti* (MCZ 13229); b) *websteri* (MCZ 2869); c) *richmondi* (IEE 91); d) *haigae* (holotype); e) *myops* (lectotype); f) *mearnsi* (IEE 117); g) *panamaensis* (holotype); h) *wollebaeki* (only undamaged part of holotype illustrated); i) *deamae* (IEE 54); j) *californica*. Second and base of first antennule flagella. k) *websteri*; l) *haigae* (holotype); m) *deamae* (IEE 54); n) *panamaensis* (holotype). Dorsal view of carapace and eye-plates. o) *esposa* (holotype); p) *myops* (lectotype). a)—j) scale = 0.5 mm; k)—n) scale = 1.0 mm; o) scale = 0.5 mm; p) scale = 1.0 mm

D e s c r i p t i o n : Carapace (Fig. 1 p) widest at anterior end, as long as broad, narrowing back to one-third from front, then widening before sides converge, from mid-line, straight back to truncated posterior end; rostrum low, smoothly rounded; ocular sinus gently concave; edge running out from base of sinus to anteriolateral lobe with only slight bulge about half way along length; anteriolateral lobes terminating in distinct spines; subrostral spine absent; edges running backwards and outwards from tip of lobe in gentle sigmoid curve to distinct lateral spines; edge lined with small teeth from mid-point between lateral spine and anteriolateral spine to rostrum;

References

Chace, F. A., and J. Haig: Comments on the proposed designation of a type-species for *Lepidopa* Stimpson, 1858. Bull. Zool. Nomenclature **19** (1962) 344.

Clarke, W. D.: Proposal of a new name, *Lepidomysis*, for the preoccupied mysidacean generic name *Lepidops* Zimmer, 1927. Crustaceana **2** (1962) 251—252.

Desmarest, A. G.: Considérations générales sur la classe des Crustacés, et description des espèces de ces animaux, qui vivent dans la mer, sur les côtes, ou dans les eaux douces de la France. 1825. pp. i—xix: 1—446.

Efford, Ian E.: Recruitment to sedentary marine populations despite dispersive drift of larval stages, as exemplified by the sand crab, *Emerita analoga* (Decapoda, Hippidae). Crustaceana **18** (1970) 293—308.

—, and J. Haig: Two new genera and three new species of sand crabs (Decapoda, Anomura, Albuneidae) from Australia. Aust. J. Zool. **16** (1968) 897—914.

Evans, A. C.: Syntypes of Decapoda described by William Stimpson and James Dana in the collections of the British Museum (Natural History). J. Nat. Hist. **1** (1967) 399—411.

Fabricius, J. C.: Entomologia systematica emendata et aucta. Secundum Classes, Ordines, Genera, Species. Adjectis Synoninis, Locis, Observationibus, Descriptionibus. **2** (1793) i—viii: 1—519.

Gomes, M. M.: Redescrição de *Lepidopa venusta* (Stimpson) e sua ocorrencia no litoral sul do Brazil (Decapoda-Albuneidae). Rev. Brasil. Biol. **25** 1 (1965) 97—103.

— Descrição de una espécie nova do gênero *Lepidopa* Stimpson, e sua ocorrencia no litoral Brasileiro (Decapoda, Albuneidae). Rev. Brasil. Biol. **28** 1 (1968) 77—86.

Holthuis, L. B.: Notes on American Albuneidae (Crustacea, Decapoda, Anomura) with the description of a new genus and species. Proc. K. ned. Akad. Wet. Ser. C. **64** 1 (1961) 21—36.

— *Lepidopa* Stimpson 1858 (Class Crustacea, Order Decapoda): Proposed use of the plenary powers to designate a type-species. Z. N. (S). 1495. Bull. Zool. Nomenclature **19** 2 (1962) 125—128.

Knight, M. D.: The larval development of *Lepidopa myops* Stimpson (Decapoda, Albuneidae) reared in the laboratory, and the zoeal stages of another species of the genus from California and the Pacific Coast of Baja California, Mexico. (In press.)

Milne Edwards, H.: Histoire naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux. 1837, 2, 1—531. (Atlas, pp. 1—32, pls. 1—42, was published in 1840.)

Stimpson, W.: Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. (Pars VII. Crustacea Anomura.) Proc. Acad. Natur. Sci. (Phila.) 1858, 225—252.

one or two of these teeth on inside edge of anteriolateral lobes longer than broad; posterior concavity smoothly rounded, slightly more pointed than semicircular; setal pattern (Fig. 1 p) characteristic of *myops* group in having extensive patterning behind central line; setae in lateral spine groove forming unbroken line, differentiating *myops* from *panamaensis* (Fig. 4 u, v); groove running around posterior edge, turning forward just before reaching posterior concavity, stopping about half way up edge of concavity (Fig. 1 e).

First abdominal somite slightly shorter than wide, exposed area crescent-shaped, lined with setae along anterior edge; second abdominal segment with large wing-like pleural expansion, anterior edge slightly concave, posterior

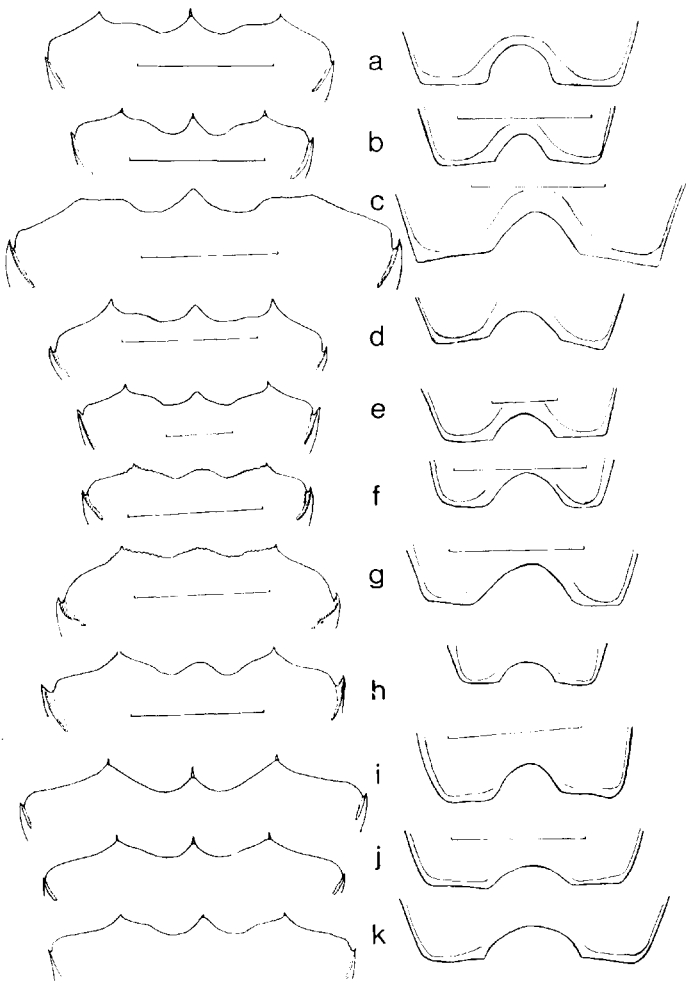

Fig. 2. *Lepidopa*. Anterior edge of carapace showing lateral spines, anteriolateral spines, and where present, the sub-rostral spine. Posterior edge of carapace showing the position of the groove which parallels the edge. a) *richmondi* (IEE 91 ♀); b) *mearnsi* (♀); c) *haigae* (holotype); d) *deamae* (IEE 54 ♀); e) *benedicti* (MCZ 13229 ♀); f) *myops* (AHF); g) *panamaensis* (holotype); h) *californica* (AHF ♂); i) *esposa* (holotype); j) *websteri* (MCZ 867); k) *mexicana* (IEE 55 ♀). Scale = 0.5 mm

edge convex; anterior corner almost a right-angle, posterior corner gently rounded; concavity in anterior edge of segment broad, with central part convex, edges short and rounded; pleural expansion on third and fourth segments with concave anterior and convex posterior edges; third expansion with anterior edge, fourth with both edges, lined with grooves containing setae; pleural expansions on fifth segment rather short and round in cross section whilst remaining stiff; sixth segment square, sides almost parallel. Telson widest one-third from proximal end, narrowing with fairly straight sides to top.

Eye-plate (Fig. 3 j) longer than broad with outer edge fairly straight, inner edge convex, curved increasingly towards distal end; distal end rounded

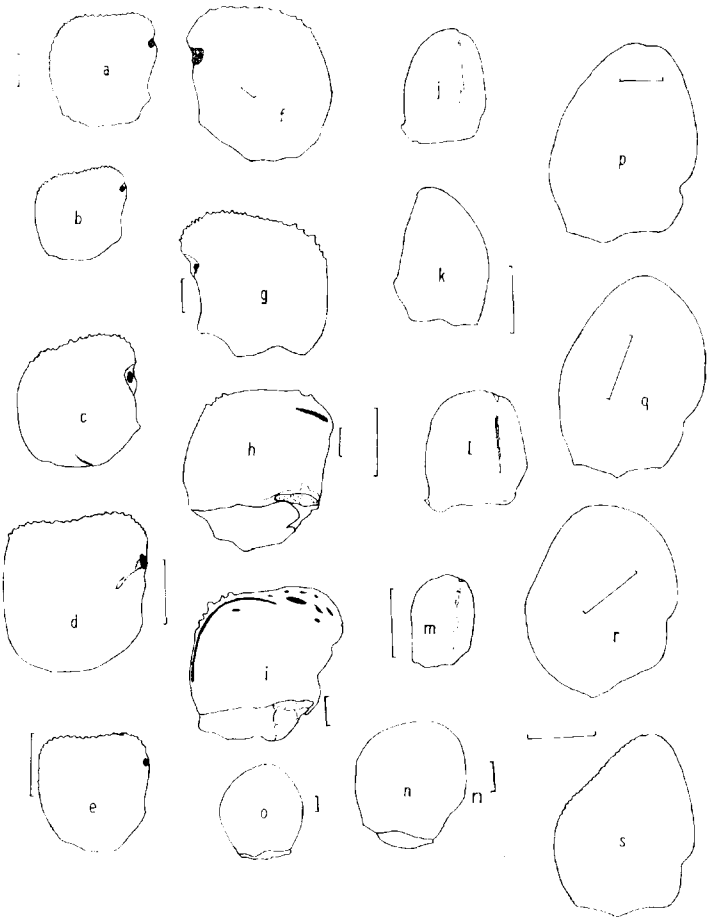

Fig. 3. *Lepidopa*. The eye-plate of species in the genus *Lepidopa*. All figures are camera lucida drawings of eye-plates after they have been removed from the animal. All are of the right eye except figures f, g, h, i and o. Figures h and i are ventral views, all others are dorsal views. a) *benedicti* (MCZ 13229 ♀); b) *haigae* (holotype); c) *deamae;* d) *richmondi* (IEE 91 ♀); e) *mcarnsi* (♀); f) *sorodeamae* (USNM 68608 ♀); g) *deamae* (MCZ 13257 ♀); h) *sorodeamae* (CL 23 ♀), ventral view showing pattern of setal attachments; i) *deamae* (USNM 68606 ♀ CL 24 mm), ventral view showing pattern of setal attachments; j) *myops;* k) *distincta* (AMNH 10363); l) *panamaensis* (holotype); m) *californica;* n) *chilensis;* o) *chilensis* (BMNH from Ancon Peru); p) *venusta* (USNM 7573); q) *esposa* (holotype); r) *websteri;* s) *mexicana* (IEE 55 ♀). Scale = 1 mm

with cornea near outside corner; upper surface smooth and shiny, and along with the edge, lacking in setae except for three or four setae right in proximal outer corner of plate; the lack of setae separates this species from all other species of *Lepidopa* except *panamaensis;* ventral side with same small group of setae found in many other species, situated on proximal edge just to one side of middle of plate.

Basal segment of antennule large, saddle-shaped, its dorsal distal corner possessing a bulge but no distinct spine; second segment S-shaped, third widening evenly towards distal end; first flagellum long and flexible with about 55

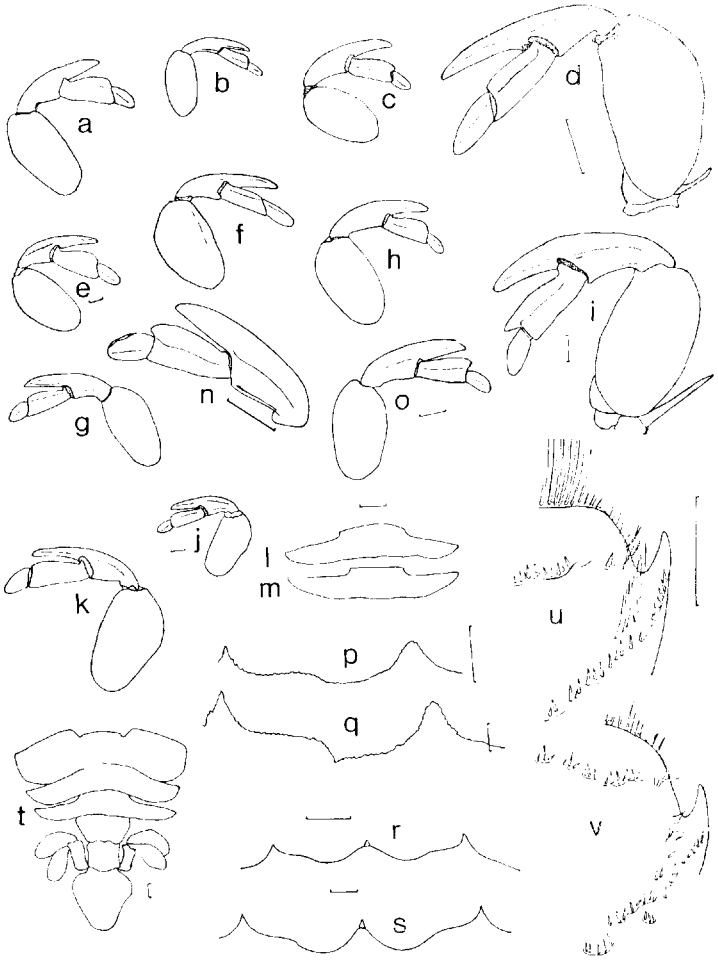

Fig. 4. *Lepidopa.* Third maxilliped. a) *deamae* (IEE 54); b) *californica;* c) *esposa* (holotype); d) *myops;* e) *benedicti* (MCZ 13229); f) *panamaensis* (holotype); g) *mcarnsi;* h) *websteri* (MCZ 867); i) *chilensis* (BMNH 1938.4.4.15); j) *haigae* (holotype); k) *richmondi* (IEE 91); l) *wollebacki* (holotype); o) *mexicana* (holotype). Dorsal view of fourth abdominal segment. l) *venusta;* m) *wollebacki.* Anterior edge of carapace of *benedicti.* p) IEE 54 CL 9 mm ♀; q) MCZ 13257 cl 23 mm ♀. [Note the shallow notch in p) and the much deeper notch in q).] r) *chilensis* (BMNH 1913.12.10.128, Ancon, Peru); s) *chilensis* (BMNH 1938.4.4.15). Dorsal view of all except the first abdominal segments. t) *venusta* (USNM 7578 ♀). Lateral spine and lateral spine groove. u) *myops;* v) *panamaensis.* Scale — 1 mm

to 60 articles; second flagellum with one article reaching to end of first article of first flagellum. Basal segment of antenna large, one side forming extended lamellate expansion as in all other species; scaphocerite short, just overlapping base of fourth segment. Flagellum with seven articles, first small as always in the genus, next four with distinctly wider distal ends, last two more cylindrical with seventh less than half as long as sixth.

Mandibular with three-segmented palp and long fine cutting edge; proximal end with two distinct rounded teeth, one set back from edge; distal end with one sharper tooth separated by short gap from similar tooth. Maxillula (Fig. 5 q), maxilla, first and second maxillipeds similar to others in genus. Anteriodorsal expansion of carpus of third maxilliped (Fig. 5 d) very long, extending over propodus and half of dactylus; exopod considerably shorter than in most other species being less than length of dactylus.

Fig. 5. *Lepidopa.* Mandible and mandibular palp. a) *benedicti*; b) *mearnsi;* c) *distincta* (AMNH 10363); d) *californica;* e) *venusta* (USNM 7973 ♀); f) *mexicana* (AHF paratype ♀); g) *websteri;* h) *chilensis.* First maxilliped. i) *mexicana* (AHF paratype); j) *deamae.* Second maxilliped. k) *venusta* (USNM 7573); l) *chilensis.* Antenna. m) *haigae;* n) *panamaensis* (holotype). Last three segments of antenna. o) *deamae;* p) *sorodeamae.* Maxillula. q) *myops.* Scale = 1 mm

First sub-chelate pereopod with carpus bearing some distinct teeth on outer edge of dactylus and on distal outer bulge of carpus (Fig. 6 a). Dactylus of second pereopod (Fig. 6 d) as in *panamaensis* (Fig. 6 b). Carpus of third pereopod typically expanded, upper surface covered with setal mat, dactylus very similar to that in *panamaensis*. Dactylus of fourth pereopod as in *distincta* except process near base more pointed in *myops* (Fig. 7 e). Fifth pereopod very long, extending forward between other pereopods along with long pleopods.

R e m a r k s : This species has the features of the *myops* group listed in the key and it can easily be separated from other species in the genus. Even the other two known members have quite distinct eye-plates.

The species has only been collected from the immediate vicinity of Cape San Lucas where it has been dredged on two occasions by the Velero III. One dredge took it at 20 m

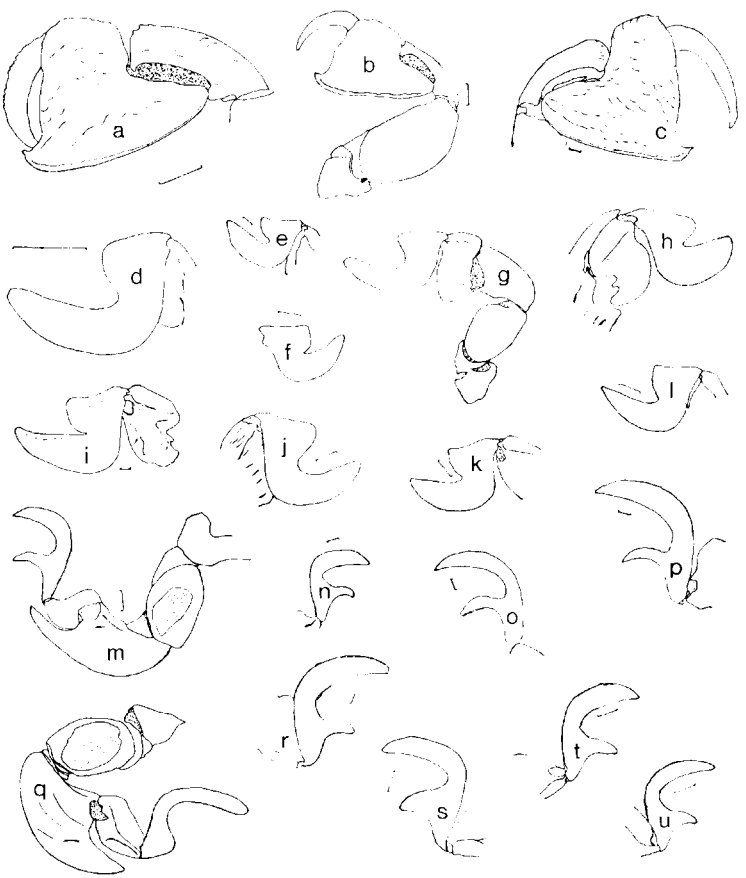

Fig. 6. Dactyla of the pereopods of *Lepidopa*. First pereopod. a) *myops*; b) *panamaensis* (holotype); c) *deamae* (MCZ 13257). Second pereopod. d) *myops*; e) *benedicti*; f) *mexicana*; g) *panamaensis* (holotype); h) *venusta*; i) *deamae* (MCZ 13257); j) *haigae*; k) *californica*; l) *richmondi*. Third pereopod. m) *mexicana*; n) *benedicti*; o) *websteri*; p) *venusta*; q) *panamaensis* (holotype); r) *deamae* (MCZ 13257); s) *haigae* (holotype); t) *californica*; u) *richmondi*. Scale = 1 mm

(11 Mar. 1949) and one at between 36 to 50 m (19 Jan. 1940). The original description did not include a statement of the actual collecting site but probably the type material was taken from a sandy beach near the Cape.

Nothing is known about the biology of the species.

Lepidopa distincta Gomes

(Fig. 3 k; Fig. 5 e; Fig. 7 f, n)

Lepidopa distincta Gomes, 1968, Rev. Brasil. Biol. 28 (1): 77—86.

Type: Gomes (1968) did not designate a holotype so the male and four females mentioned in the original paper are syntypes. This type material was not examined in this study.

Distribution:

Brazil: Ilha do Pai, State of Rio Janeiro; 9°53′20″S, 35°51′20″W and 10°5′20″S State of Alagoas (Gomes 1968); near Fortaleza, 3°34′01″S, 38°32′03″W, State of Ceará (Dr. José Fausto Filho Coll.).

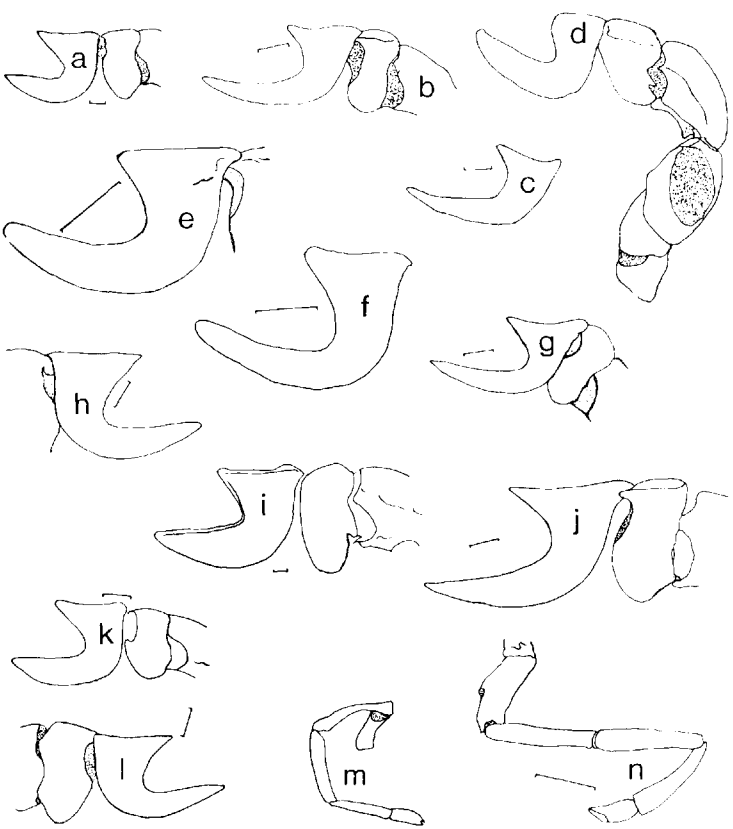

Fig. 7. Dactyla of the pereopods of *Lepidopa*. Fourth pereopod. a) *benedicti;* b) *venusta;* c) *mexicana* (ZMK); d) *panamaensis* (holotype); e) *myops;* f) *distincta* (AMNH 10363 ♀); g) *esposa* (holotype); h) *haigae* (holotype); i) *deamae;* j) *chilensis;* k) *californica;* l) *richmondi*. Fifth pereopod. m) *panamaensis* (holotype); n) *distincta* (AMNH 10361 ♂). Scale — 1 mm

Dominican Republic: Barahona Harbour, K 932—33 Armstrong Santa Domingo Expedition. (AMNH 10361 ♂ cl. 6 mm; AMNH 10362 ♀ cl. 5 mm; USNM 122635 ♀ cl. 9 mm; BMNH Crust. D. 23986 ♀ cl. 6 mm; BMNH 1968–55 ♀ (?) cl. 4 mm.)

Description: The following description is based on the material from the Dominican Republic.

Carapace widest at level of lateral spines, narrowing to waist one third from anterior end, then bulging out to second wide part at mid-line before sides converge towards truncated posterior end; posterior concavity smoothly rounded; rostrum more triangular with rounded end than in either *myops* or *panamaensis;* ocular sinus shallowly concave near rostrum but then running almost straight, with slight concavity, out to anteriolateral lobe, edge then following sigmoid curve out to large, conspicuous lateral spine, these spines extending forward level with anterior edge of carapace; anterior edge with spine on each anteriolateral lobe but subrostral spine absent; entire anterior edge, including rostrum, with small teeth but none longer than broad; between them, long fine setae with a few fine side setae; setal pattern on carapace as in the other two *myopos* group species, a pattern of setae occurring behind central line on carapace; male with second line running along just in front of central line; line absent in females except as scattered groups of setae; lateral spine groove lined with unbroken row of setae, as in *myops* (Fig. 4 u) but differing from *panamaensis;* groove along posterior edge of carapace paralleling edge of concavity a short way before stopping.

First abdominal somite shorter than broad, narrowing at anterior end, with small crescent shaped exposed area lined with setae at anterior edge, pleural expansions of second abdominal segment large with straight anterior edge; third and fourth expansions narrower, anterior edge distinctly concave; anterior edge of third pleural expansion paralleled by setal groove; anterior and posterior edges of fourth expansion with similar groove; fifth segment short, narrowing towards posterior end, carrying short, slightly bent, thin pleural expansions; sides of sixth segment straight and parallel. Telson almost round, but with gentle concavity on either side near posterior end, giving slight pear-shape.

Eye-plate (Fig. 3 k) quite distinct as outside edge is almost straight, except for slight concave section near tip; inner edge convex, forming one continuous smooth curve from near base to rounded tip; no eye-spot or cornea visible; outer edge with row of longish fine setae along middle section; upper surface smooth and shiny; lower surface with group of short setae similar to that in *panamaensis* on proximal edge near straight outer side.

Basal segment of antennule large and broad, terminating in large spine just to one side of attachment point of second segment; second and third segments as in other species; only specimen with antennule flagella unbroken is the smallest one (cl. 4 mm), first flagellum with 45 articles and longer than carapace, second flagellum with one (possibly two) articles, and reaching to end of first article of first flagellum. Antennal scaphocerite relatively long,

reaching almost half way up edge of fourth segment; fifth segment quite long and cylindrical, terminating in flagellum of seven articles; second to sixth segments enlarged at distal end; terminal articles cylindrical, no longer than sixth article.

Mandibular palp three-segmented, cutting edge not divided in half by tooth as in *mexicana* (Fig. 5 c). Third maxilliped typical of *myops* group in having carpus extended right over propodus and overlapping first third of dactylus; dactylus relatively long, almost as long as propodus; exopod a long slender single segment; third maxilliped covered with very long stiff setae.

First pereopod typical of those in genus but with more setae, particularly on propodus, than in most species. Dactylus of second pereopod as in *panamaensis* except bulge near base slightly more rounded at outer end. Dactylus of third pereopod as in *panamaensis* (Fig. 6 g) but with bulge near base more pointed in *distincta;* carpus of third pereopod greatly enlarged as in *panamaensis* and equally setose on upper surface. Dactylus of fourth pereopod unlike that in *panamaensis* and with very long side process near distal end (Fig. 7 f).

Remarks: *Lepidopa distincta* is the most distinctive of the *myops* group because it has an eye-plate which narrows almost to a point at the distal end and which bears some setae around the edge of the plate. It is the first species in the *myops* group to have been found on the East Coast of the Americas. The presence of a long carpus, extending over the propodus and overlapping the first third of the dactylus clearly places this species in the *myops* group and shows that it is not closely related to *L. venusta* as Gomes (1968) suggested.

The species has been recorded down to 20 m off the coast of Brazil, and in the harbour at Barahona in the Dominican Republic.

Lepidopa panamaensis sp. nov.

(Fig. 1 g, n; Fig. 2 g; Fig. 3 l; Fig. 4 f, v; Fig. 5 n; Fig. 6 b, g, q; Fig. 7 d, m)

Types: Holotype ♀ cl. 8 mm and paratype ♀ cl. 8 mm both in ZMK.

The specific name is an adjective after the locality.

Distribution:

The holotype if from Taboguilla, Panama and was collected by the Dr. Th. Mortensen's Pacific Expedition 1914—16 on the 8th December, 1915. The paratype is from the southwest corner of Rey Islas Perlas, collected during the same expedition on the 26th January, 1916.

Description: Carapace (Fig. 2 g) resembling that of *myops* to which this species is most closely related, widest at anterior end, narrowing to slight waist about one-third from front, widening again before straight sides converge; posterior end truncated with fairly deep rounded medial concavity; rostrum gently rounded, edge of ocular sinus shallowly emarginate near rostrum, then running with slight convex curve, straight out to anteriolateral

lobe; edge following gentle sigmoid curve from lobe out to large, distinct, lateral spine; anterior edge of carapace toothed, some of teeth, particularly along inside edge of anteriolateral lobes, longer than broad; anteriolateral and subrostral spines absent; edge with long setae; setal pattern on surface of carapace almost identical to that found in *myops* (Fig. 4 p), distinguished from latter species by groove from lateral spine having setae broken up into small groups rather than forming unbroken line as in *myops* (Fig. 4 u, v); along with *myops* and *distincta*, differing from other *Lepidopa*, except *haigae*, in having pattern of setae behind line of setae which runs across central line; groove around posterior edge of carapace following edge of medial concavity about half way forward, then stopping (Fig. 2 g).

First abdominal somite broader than long, slightly wider at posterior end (Fig. 4 g); exposed section forming crescent shaped area with short setae lining anterior edge; concavity in anterior edge of second abdominal segment very wide and shallow, central part so convex that it reaches forward level with anterior edge of pleural expansion of this segment; second to fifth abdominal somites inclusive with pleural expansions; expansions of second segment being largest; anterior distal corner almost a right-angle, posterior distal corner rounded; anterior edge of expansion straight; edges lined along anterior and lateral sides with forward projecting setae; posterior edge without setae except near junction with body; this setal pattern repeated on much narrower pleural expansion of third segment; pleural expansion on fourth segment resembling third, shorter, with setae in groove all along posterior and anterior edges. Telson egg-shaped with sides running almost straight back, with only slight bulge from widest part to tip.

Eye-plate (Fig. 3 l) longer than wide, corners rounded; outer edge straight, inner edge convex with increasing curvature towards outer edge; distal end slightly convex with cornea in notch near outer corner; inner proximal corner of plate with small process; upper and lower surfaces completely smooth, lacking setae; edge of plate without setae except for a few on both upper and lower surfaces in outer proximal corner.

Antennular basal segment very broad, saddle-shaped, second segment shorter, third segment as long as second, widening markedly towards distal end; first flagellum missing from holotype; in paratype, flagellum longer than carapace, thin, flexible, with 53 articles; second flagellum very short, reaching only to end of first article of first flagellum, with two articles (Fig. 4 n). Antenna (Fig. 5 n) with very short scaphocerite; flagellum with seven articles, puts this species in *myops* group as all other *Lepidopa* usually have eight; articles wider at distal end; antenna with setae, particularly on flagellum, that are stronger than usual within the genus, although typical of *myops* group.

Mandible with three-segmented palp and resembling others in family. Maxillular palp very broad, terminal spines on lower lacinia longer and stronger than those of wider, upper lacinia. Maxilla typical of others in family. First and second maxillipeds with general form of those in family. Third maxilliped (Fig. 4 f) distinct in that anteriodorsal expansion of carpus projects

right over propodus and over part of dactylus, this being characteristic of *myops* group; dactylus over half as long as propodus; third maxilliped with areas of densely arranged, long setae, as in other members of *myops* group.

Pereopods typical of those in genus (Fig. 6 and 7). Pleopods on holotype long, extending forward between pereopods.

Remarks: *Lepidopa panamaensis* is the second Pacific Coast member of the *myops* group and can clearly be separated from the Caribbean species, *distincta* by the presence of large truncated eye-plates in *panamaensis*. It has more distinct teeth along the anterior edge of the carapace than either *myops* or *distincta* and the rostral region is smoothly rounded, unlike *myops* where the rostrum is slightly more triangular with a rounded tip. The broken line of setae on the corner of the carapace (Fig. 4 u, v) separates the two Pacific species *myops* and *panamaensis*.

This species has been recorded from the Islas Perlas group off the coast of Panama. The holotype was collected on a shell-sand beach, at very low water, and the paratype was dredged in 20 to 30 m from a bottom of shell-sand.

Lepidopa californica sp. nov.

(Fig. 1 j; Fig. 2 h; Fig. 3 m; Fig. 4 b; Fig. 5 d; Fig. 6 k, t; Fig. 7 k)

Lepidopa myops Holmes, 1900, Occas. Pap. Calif. Acad. Sci., Ser. 4, 32 (8): 105 (part); Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 892, Fig. 4; Rathbun, 1904, Harriman Alaska Series (Crustaceans, 10): 167 (part); Baker, 1912, First Ann. Rept. Laguna Mar. Lab. (Pomona College): 102; Schmitt, 1921, Publ. Zool. Univ. Calif., 23: 172 (part); Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 188, fig. 1 b, 2 a and j (part); Johnson and Lewis, 1942, Biol. Bull., 83: 86 and pl. 8; following auct. nec. Stimpson 1860.

Type: Holotype ♂ cl. 7 mm, cw. 11 mm USNM 42243 from Long Beach California, collected by J. E. Benedict on 24th June, 1905. Paratypes (USNM 122633) from the same collection as holotype and BMNH 1937.6.4.4—5.

The specific name is a noun in apposition.

Distribution:

U. S. A. California, San Diego (Holmes, 1900: 105; Benedict, 1903, 892; USNM 18865; AHF, off Point Loma, Velero III sta. 1243—41); Laguna Beach (Baker, 1912: 102); San Pedro (Schmitt, 1921: 172; USNM Acc. No. 41075); La Jolla (Gordon, 1938: 188; IEE 51; USNM 53932; RMNH 4924); Long Beach (BMNH 1959.8.5.73—74 and 1937.6.4.4—5 which is from USNM 14638; AHF one dry specimen); Corona del Mar (RMNH 14638; USNM 89484).

Mexico: South of Pond Id., Angel de la Guardia, Gulf of California (AHF, Velero III, sta. 1080—40).

Description: Carapace in *californica* typical of those in *venusta* group, broader than long, widest at lateral spines, narrowing rather sharply behind lateral spines to about one-third back, then widening for another third before edges straighten and converge towards truncated posterior edge; emargination in posterior edge semicircular; rostrum relatively small and rounded but sides slightly concave (Fig. 2 h), running gently back into ocular sinuses; on other side of each sinus, edge curving more sharply forward and outward

to anteriolateral lobes, then back and out in one continuous curve, bending back just before lateral spine; lateral spines large and conspicuous, extended forward so they project beyond nearest part of anterior edge of carapace; anteriolateral spines long, very sharp but subrostral spine absent; edge of anteriolateral lobes lined with very small teeth but these latter not occurring along edge of ocular sinus or rostrum; anterior edge of carapace lined with very long setae, those in rostral region extending right over and beyond distal end of eye-plates; setal pattern on carapace the minimum found in *Lepidopa* (cf. *esposa* Fig. 1 o) setae being very inconspicuous; ends of groove around posterior edge of carapace bending forward slightly when groove stops at central emargination.

First abdominal somite broader than long, narrowing towards anterior end (Fig. 1 j); exposed section crescent-shaped, anterior edge fringed with setae; second abdominal somite with very wide emargination in anterior edge, central part of which is convex; sides sloping inward from pleural expansions; anterior edge of pleural expansion almost completely flat, sloping slightly backward; anterior corner of expansion a rounded right-angle, posterior corner broadly rounded; third and fourth pleural expansions both emarginated along anterior edge; fifth segment widest at anterior end, narrowing to about half the width at posterior end; pleural expansions thin, leaf-like, curving backwards then outwards; sixth segment almost square. Telson pear-shaped, a little broader than long.

Eye-plate (Fig. 3 m) almost rectangular, longer than broad, except for proximal outer corner which curves in towards base quite sharply; corners rounded, small corneal area present on distal edge near outer corner; eye-pigment not usually visible; dorsal surface of plate smooth and shiny, with short setae lining outer edge only; ventral side of plate differing from those in *venusta* group, being smooth and shiny, the only setae attached near outer edge of plate; in presence of setae along outer edge, this species is clearly separated from *myops* whose geographical distribution it appears to straddle but not overlap.

Basal segment of antennule large, saddle-shaped, second segment with distinct rounded bulge to one side, third segment typical; first flagellum very long (over three times as long as carapace), flexible, consisting of 40 to 45 articles; second flagellum of antennule with two (range 1—3) articles, reaching usually to second (range 1—3) article of first flagellum. Antennal scaphocerite very short; flagellum with eight articles; second to sixth broadest at distal ends but two terminal articles cylindrical, about equal in length. Mandible (Fig. 5 d) with three-segmented palp and lacking long straight cutting edge and distinct tooth found near distal end in most species. This may be more a character of an old individual, however, as other specimens examined had a fairly long straight cutting edge. Second segment of exopod of second maxilliped short, about as long as carpus, thin and pointed. Carpal expansion of third maxilliped not reaching to end of propodus and exopod short, reaching only one-third length of merus (Fig. 4 b).

First pereopod sub-chelate, similar to others in genus. Dactyla of next three pereopods similar to those in *venusta* group (Fig. 6 and 7). Process near base of third blunter than in other species, long relative to main blade of dactylus and also nearer proximal end. Fourth pereopod with process near base of dactylus blunter than in other species in group. Fifth pereopod chelate with distinct setal fringed genital pore in male.

Remarks: *Lepidopa californica* is the only species which does not fit clearly into one of the three groups of species. The eye-plate fits into that of the *myops* group but the third maxipilled and carapace patterning are closer to the *venusta* groups. The absence of a subrostral spine suggests it should be placed in the *benedicti* group as all species in the *venusta* group have a subrostral spine. At the present time the species must be left in a group of its own and there is a strong suggestion from the available data that the species may be more closely related to a more generalised, ancestral form of *Lepidopa* than are any of the other species we now know.

Almost all the records published on the species are from California where up to now it has been identified as *myops*. It is common on sandy beaches in southern California where it is usually found well down on the beach and exposed only at low tide. Sometimes it occurs higher on the beach near the top of the wash zone. It has also been found in deeper water, for example off Point Lomo, San Diego in a dredge taken between 18 and 26 m (Velero III, 23rd Feb 1941, AHF) and between 124 and 152 m off Angel de la Guardia Id. in the Gulf of California (Velero III, 5 Feb 1940, AHF). The zoeae have been described in some detail by Johnson and Lewis (1942) and Knight (in press) but little else is known about the biology of the species. It resembles *websteri* in being one of the two best collected species which might explain why it is also one of the only species where a fair number of males are known. The females are considerably larger than the males with the record being cl. 17 mm for females and cl. 12 mm for males.

Lepidopa benedicti Schmitt

(Fig. 1 a; Fig. 2 e; Fig. 3 a; Fig. 4 e, p, q; Fig. 5 a; Fig. 6 e, n; Fig. 7 a)

Lepidopa benedicti Schmitt, 1935, Sci. Sur. Porto Rico and Virgin Ids., New York Acad. Sci., 15 (2): 210; Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 187, fig. 2 e, g—i; Holthuis, 1960, Proc. K. Nederland Akad. Wet. (Ser. C), 64 (1): 33, fig. 5.

Lepidopa scutellata, Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 894, fig. 6; Schmitt, 1935, (as above): 209 nec. Stimpson 1858.

Albunea scutellata. H. Milne Edwards, 1837, Hist. Natur. Crust., 2: 204, pl. 21, fig. 9 to 13.

Type: The lectotype for *benedicti* was selected by Holthuis (1960) and is deposited in USNM 104656. It was collected from the outer beach of Santa Rosa Island, Pensacola, Florida in 1893 by J. E. Benedict. Two paralectotypes were selected by Holthuis at the same time, these were from the same location as the lectotype (USNM 29020) and from Morris Cut, off Miami, Florida (USNM 29019) another collection taken by J. E. Benedict. I examined all the type material.

Distribution:

U. S. A. Florida Santa Rosa Island, Pensacola (type locality of lectotype USNM 104656 and syntype USNM 29020 selected by Holthuis, 1960: 34; Gordon 1938: 187), Pensacola (Benedict, 1903: 894; Holthuis, 1960: 34; USNM 4603 and 68614); Panama

City (IEE 54), Alligator Point, Franklin Co. (Holthuis, 1960: 34; USNM 95592), Pompano Beach (AHF coll. E. R. Tinkham); Palm Beach (USNM 159502; MCZ 43254), Ocean Beach north of Fort Worth Inlet (Gordon, 1938: 187; Holthuis, 1960: 34; USNM 68640), Morris Cut opposite Miami (Benedict, 1903: 894; Holthuis, 1960: 34 paralectotypes selected by Holthuis USNM 29019), Miami (Gordon, 1938: 187; MCZ 9823; PANS 4760).

Alabama: Gulf State Park (Holthuis, 1960: 34; USNM 81028), Petit Bois Id. (Holthuis, 1960: 34; USNM 95750), Dauphin Id., Mobile Co., (TU 4303), Gulf Shore, Baldwin Co. (TU 4348).

Mississippi: Ship Id. (Holthuis, 1960: 34; USNM 92433 and 90297).

Louisiana: (Gordon, 1938: 187), Grand Id., Jefferson Co. (Holthuis, 1960: 34; USNM 63254; TU 5538; RMNH 14631).

Texas: Padre Id. (Gordon, 1938: 187; Holthuis, 1960: 34; USNM 50568), Galveston (Holthuis, 1960: 34; USNM 78066), Mustang Id. (Holthuis, 1960: 34; USNM 72183), N. E. of Port Bolivar, Chamber Co. (TU 4301).

Mexico: S. E. of Veracruz, near Mocambo (TU 4320).

Description: Carapace just wider than long, narrowing behind lateral spines, widening again to a point just behind middle of carapace, then narrowing towards truncated posterior end; emargination in posterior edge of carapace semicircular. Rostrum triangular with end rounded and resembling that in other species in group (Fig. 2 e); anterior margin of carapace sometimes with smooth sinusoidal curve in ocular sinus but in other specimens, ocular sinus divided into two distinct parts, a concave medial half and a convex lateral half (Fig. 4 p, q); junction between two halves frequently a distinct angle; short groove running backwards from edges sometimes present. Carapace edge sloping in one smooth curve out from anteriolateral lobe to lateral spine region, then turning posteriorly rather suddenly to base of spine; lateral spines large, projecting outwards and forwards; anterior edge entirely lined with round small teeth and very long setae extending well over eye-plates; two distinct anteriolateral spines present but no subrostral spine; groove around posterior edge of carapace turning forward upon reaching concavity, continuing forward, not following edge of concavity, beyond most anterior part of concavity, then stopping without meeting groove on other side (Fig. 2 e); in this *benedicti* resembles *deamae* and *sorodeamae* closely.

First abdominal somite shorter than wide, narrowing towards anterior end (Fig. 1 a); exposed region not very wide, almost straight, anterior edge lined with spines; second segment with fairly deep, wide emargination in anterior edge, sides almost parallel; pleural expansions on this segment very wide, with slightly concave anterior edge, anterior and posterior lateral corners forming near right-angles; in most species posterior corner much more rounded; third and fourth segments resembling others in group with anterior edge of pleural expansion emarginated especially near middle; fifth segment widest at anterior end, pleural expansions bending forwards towards their distal ends; sixth segment almost square with posterior edges flaired. Telson almost round but with very slight emargination on each side near tip.

Eye-plate (Fig. 3 a) typical of *benedicti* group, almost square with eye-spot and cornea just behind corner on outside edge, whole distal edge lined with evenly spaced rounded teeth; long setae arising between these teeth and

lining edge of distal half of plate; upper and lower surfaces of plate smooth, shiny; setae only along edge of plate, never on plate surface. Antennules resembling others in genus: first flagellum long and setose, consisting of 86 articles, second flagellum with two or three articles (1 in small individuals), reaching to middle of second or beginning of third article of first flagellum. Antennal scaphocerite almost twice as long as broad, reaching almost one-third of length of fourth segment; flagellum with eight articles (range 7—10), second to fifth with distinctly broadened distal ends, last one cylindrical, longer than penultimate one.

Mandible with three teeth at proximal end of cutting edge, two at distal end separated by a "V" shaped cut (Fig. 5 a); palp three segmented. Second maxilliped with very long second segment of exopod, almost half as long as first segment. Exopod of third maxilliped less than half as long as merus, thin and round in cross section: carpus of this appendage not extending to end of propodus (Fig. 4 e).

Sub-chelate first, third (Fig. 6) and fifth pereopods resembling others in genus; on second pereopod, cleft in dactylus different in having rounded bottom (Fig. 6 e). Dactylus of fourth pereopod with terminal blade not as long as in many other species (Fig. 7 a).

Remarks: *Lepidopa benedicti* possesses the characteristics of the *benedicti* group of species. The absence of a subrostral spine and the shape of the groove around the posterior edge of the carapace separates it from *richmondi*, its relative in the Caribbean. Its nearest relatives are, however, *deamae* and *sorodeamae* on the Pacific Coast from which it is more difficult to separate (see under *deamae*).

The largest female recorded was 22 mm cl. and the largest male 4 mm. I have only seen two males in the collections examined. Possibly because they are small the males are less conspicuous and less frequently collected. The species has been collected on beaches, sometimes near the water line at low tide, but it has never been collected in deep water.

Nothing has been published on the reproduction or other aspects of the biology except Benedict's (1903) note that the gut contained "the setae of annelids, the skin of a very small Synapta with some anchor plates still present, and parts of the flagellae of some small Crustacea".

Lepidopa deamae Benedict

(Fig. 1 i, m; Fig. 2 d; Fig. 3 e, g, i; Fig. 4 a; Fig. 5 j, o; Fig. 6 c, i, r; Fig. 7 i)

Lepidopa deamae Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 893, fig. 5 f; Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 187, fig. 2; Holthuis, 1954 a, Zool. Verhand., 23: 15, pl. 1, fig. 1; Holthuis, 1954 b, Comun. Inst. Trop. Invest. Cient., 3 (4): 159—166; Borr, 1955, Senck. biol., 36 (142): 51, pl. 4, fig. 5 a—b.

Type: The holotype is in the USNM 26170. It was collected from Salina Cruz, Gulf of Tehuantepec, Mexico. There are no paratypes.

Distribution:

Mexico: Salina Cruz, Gulf of Tehuantepec (type locality, USNM 26170); Acapulco (MCZ 13257); Piere Marques Beach, South of Acapulco (IEE 54).

El Salvador: Playa los Blanchos, South of Zacatecoluca, La Paz (Holthuis, a, 1954: 15; Holthuis, b, 1954: 161); Mendez (Borr, 1955: 51).

Costa Rica: Puntarenas (Gordon, 1938: 187; PANS 4736; USNM coll. A. Alfaro); Mata de Limon (HEE 33 a).

Panama: Rio Chame, Gulf of Panama (USNM Acc. No. 144344; RMNH 14629).

Description: Carapace longer than wider, widest at anterior end, narrowing from lateral spines to point about one-quarter from anterior end, then widening to about mid-point before straight edges converge towards truncated posterior end; rostrum a steep-sided triangle with quite a sharp point; concave sides sloping down from rostrum to back of ocular sinus; distinct angle frequently present on edge in middle of sinus, as in *benedicti*, edge then running sharply forward and curving outwards in sigmoid curve to anteriolateral spine (Fig. 2 d); groove frequently present running short distance back from angle across surface of carapace; in other specimens, this angle and groove less conspicuous or almost absent; distinct spine present on each anteriolateral lobe but no subrostral spine; anterior edge lined with short blunt teeth; setal pattern on carapace typical of genus with a little additional patterning behind central line; groove around edge of carapace following semicircular posterior concavity round for about half way; groove then continuing forward and almost converging, whilst edge of concavity turns towards mid-line (Fig. 2 d); groove never meeting in middle.

First abdominal segment wider than long, narrowing towards truncated anterior edge, exposed portion relatively small, shaped like a flattened crescent, anterior edge lined with setae; pleural expansion on second abdominal segment very large with slightly concave anterior edge; anterior corner rounded, more acute than right-angle; posterior corner rounded; concavity in anterior edge of segment broad, not very deep; sides rounded, central part slightly convex (Fig. 1 i); third and fourth pleural expansions convex behind, concave in front; as in all species, third with a groove of setae along anterior edge, fourth along both edges; fifth segment broad at anterior end, narrowing noticeably; pleural expansions short and stiff, curving slightly forward; sixth segment almost square. Telson nearly round.

Eye-plate in younger animals almost square but in older animals distal outside corner expanded into distinct bulge (Fig. 3 e, g); eye-spot present outside edge one-third from distal end; from eye-spot round to same position on other side of plate, edge lined with large teeth which are particularly large near inside distal corner; almost entire edge lined with long setae, upper surface smooth, setae-free and shiny; lower surface with setae round the distal and inner edge, arranged in distinct rows, and some around proximal outer corner, otherwise, smooth and shiny like dorsal surface.

Basal segment of antennule large, saddle-shaped but without spine on distal end; second segment with distinct bulge to one side, proximal end bulge more acute than a right-angle; third segment very narrow, widening sharply, sides parallel for distal two-thirds of its length; flagellum longer than carapace but not as long as in other species; second flagellum of antennule with 2 to

3 articles, reaching as far forward as fourth (range 3—5) article of first flagellum. Antenna with wide flattened basal segment and long scaphocerite, extending forward almost as far as middle of fourth segment; flagellum with eight articles, first very short, next four expanded at their distal end and overlapping segment in front, last two cylindrical, about equal in length but eighth considerably thinner.

Mandible on large specimen examined had cutting surface worn flat and looked as if it might soon have worn through in middle. Exopod of first maxilliped with two broad segments, second being almost as long as first. Exopod of second maxilliped very long, consisting of two segments, second being long and thin. Third maxilliped with expanded carpus extending over propodus to junction with dactylus but not overlapping junction itself; exopod short, as in *myops* (Fig. 4 a) and round in cross section.

First pereopod with part of propodus nearest dactylus narrowing towards distal end whereas in other species it is usually broad (see *myops* Fig. 6 a and *panamaensis* Fig. 6 b). Second pereopod with anterior end of carpus extended to form distinct point almost reaching to end of propodus; dactylus (Fig. 6 e) with deep cleft in inside edge formed by bulge near proximal end; six small groups of setae line cutting edge in large specimen illustrated (MCZ 13257, ♀, cl. 24 mm). Dactylus of third pereopod with long narrow process near proximal end, (Fig. 6 r) resembling that in *mexicana* (Fig. 6 m); carpus of pereopod greatly expanded, dorsal surface of distal half covered with a mat of setae. Fourth pereopod with normal horn-shaped dactylus and propodus with outside edge expanded considerably to form plate-like segment much wider than long (Fig. 7 i).

Remarks: *Lepidopa deamae* is closely related to *benedicti* and is difficult to separate from the latter except using the difference in the eye-plates. Both species are closely related to *sorodeamae* which differs from *deamae* in not having the rows of setae on the back of the eye-plate, found in *deamae*, and differs even less from *benedicti* only being separable by the number of teeth lining the distal edge of the eye-plate.

Some of the females in *deamae* are the largest known for the genus and one reaches 34 mm cl. No males are known. All specimens have been collected from the intertidal region on tropical sandy beaches and nothing is known about the biology of the species.

Lepidopa sorodeamae sp. nov.

(Fig. 3 f, h; Fig. 5 p)

Type: Holotype ♀ 20 mm cl. 22 mm ew. at the lateral spines USNM 106450. Collected from Mancora, Peru in the intertidal region by W. L. Klawe on the 21st June 1960.

Distribution:

Ecuador: Salanga Id. (USNM 68608).
Peru: Mancora (USNM 106450).

D e s c r i p t i o n : This new species is sufficiently similar to *deamae* that for some time I believed it to be just a variant. Here I will list just the differences that I have been able to find between the two, in all other characters it fits the description just given for its more common sister species.

Last article of antennal flagellum longer than seventh article in *sorodeamae* but the two articles about equal in length in *deamae*. Eye-plate more rounded than in *sorodeamae*, especially the inner edge; outer edge with relatively few teeth (about 10), well spaced apart, not almost touching; entire distal edge of plate lined by dense row of setae; dorsal surface of plate smooth, lacking setae except along outer half of proximal edge; ventral surface lacking setae except for a few scattered setae in line just above eye-spot (Fig. 3 h), this last character clearly separating *deamae* (Fig. 3 i) from *sorodeamae* because in *deamae*, ventral surface of eye-plate possesses long rows of setae lining edge of plate. Even in largest specimens, no expansion of distal lateral corner of eye-plate occurs as it does in *daemae;* in this, the species resembles *benedicti* as it did in lack of rows of setae lining ventral side of distal edge of plate. Just as in *deamae* and *benedicti* this new species is variable in the ocular sinus; sometimes it possesses a small notch which runs back onto the carapace and sometimes not.

The species is named from the latin word soror for sister and refers to the relationship between it and *deamae* although, it should be noted, that it is probably more closely related to *benedicti.*

Lepidopa mearnsi Benedict

(Fig. 1 f; Fig. 2 b; Fig. 3 e; Fig. 4 g; Fig. 5 b)

Lepidopa mearnsi Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 895, fig. 7.

T y p e : The holotype is in the USNM (26171) and is in poor condition. The type locality is only known as "west coast of Central America".

D i s t r i b u t i o n :

The type locality is West Coast of Central America.

M e x i c o : Piere Marques Beach, South of Acapulco (IEE 100); Norse Beach, 5 miles north west of Puerto Penasco, Sonora (Coll. of C. A. Westervelt).

N i c a r a q u a : Masachapa, Managua Dept. (TU 4657).

C o s t a R i c a : Mata de Limon (IEE 33).

D e s c r i p t i o n : Carapace of *mearnsi* very similar to that of *richmondi,* slightly wider than long, with waist about one-third back, then a wide part one-third from posterior end; rostrum (Fig. 2 b) broadly triangular with rounded tip, slightly concave sides curving around to outer edge of ocular sinus; convex region present between sinus and anteriolateral lobes but not very pronounced; edge running out from anteriolateral lobe to lateral spine with slight concavity, then turning suddenly to meet the spine; lateral spines not large or protruding, not projecting beyond anterior edge of carapace; both anteriolateral lobe spine and subrostral spine present; groove around posterior edge

of carapace following edge of posterior concavity but never actually meeting in middle (Fig. 2 b); in this character the species resembles *haigae* but no other member of the genus; posterior concavity deeper and narrower than semicircular shape.

First abdominal somite (Fig. 4 f) just a little shorter than wide, with very small crescent-shaped row of setae marking exposed region; second segment with narrow deep emargination in anterior edge with almost parallel sides; pleural expansions straight across anterior edge, very broad and with anterior corner a rounded right-angle but posterior corner a wider curve; third and fourth pleural expansions typical of genus with their anterior edges emarginated; fifth segment widest at anterior edge, narrowing to about half the width, pleural expansions quite long and narrow, reaching more than three-quarters of way to end of fourth expansions; sixth segment shorter than wide, with flaired anterior and posterior ends. Telson wider than long, almost round but sides nearest tip slightly flattened just before rounded end.

Eye-plate (Fig. 3 e) squarish, proximal outer corner cutting in rather sharply and inner edge forming continuous curve along that side; corners rounded; eye-spot and cornea situated about one-third from distal end on outside edge of plate; outside edge lined with evenly spaced rounded teeth; these teeth generally not as large as in other members of *benedicti* group; edges of distal half of plate with setae about half as long as plate; both sides of plate smooth and shiny, lacking setae except round edges.

Second flagellum of antennule with one to three articles extending as far as beginning of second or third article of first flagellum. Antennal scaphocerite twice as long as broad, extending one-third of way along fourth segment; fifth segment twice as long as broad, terminating in flagellum of eight articles; second to sixth articles with expanded distal ends; last two cylindrical, almost equal in length.

Mandible (Fig. 5 b) with three-segmented palp; distal end of segment with long flat edge running from palp down to cutting edge; this edge more curved in most species; cutting edge fairly long with two teeth at one end, and one at the other (proximal) end, proximal tooth having a row of three large round teeth behind it. Second maxilliped with second segment of exopod about one-third as long as first segment. Carpus of maxilliped (Fig. 4 g) extended just to end of propodus, exopod half the length of merus.

Pereopods very similar to those of *richmondi* except proximal process on second dactylus more rounded in *mearnsi*. Fifth pereopod in some specimens with open genital pore at same time as partially developed pore on third pereopod. This seems to be good evidence that the males change to females at some stage in development. In the case mentioned the animal carried small pleopods whereas larger specimens that only have a female opening have long well developed pleopods.

R e m a r k s : The holotype has the emargination in the anterior edge of the second abdominal somite with deeper sides and the edges parallel compared to other specimens that I have examined, where the concavity is not so

deep and the sides slope inwards. Also the holotype has the ocular sinus divided into two equal halves by a rounded projection. Other specimens differ in this character also in that the more lateral half is less concave and the edges curve more gently forward and outward towards the lateral lobes. At the present time, I have assumed that these differences between the holotype and other specimens are due to within-species variation.

Nothing is known about the biology of the species which has been collected on sand beaches along the Pacific coast of Central America.

Lepidopa richmondi Benedict

(Fig. 1 e; Fig. 2 a; Fig. 3 d; Fig. 4 k; Fig. 6 l, u; Fig. 7 l)

Lepidopa richmondi Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 895, fig. 8; Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 188, fig. 2 d; Holthuis, 1960, Proc. K. Nederland Akad. Wet., Ser. C, 64 (1): 31, fig. 4; Da Costa, 1962, Centro Estud. Zool., 14: 9—10.

Lepidopa fernandesi Mendes, 1945, Arq. Museu Paranaenae, 4: 120, pl. 13 (syn. Holthuis, 1961).

Lepidopa scutellata Stimpson, 1859, Ann. Lyc. Natur. Hist. New York, 7: 79 (syn. Schmitt 1935).

Type: Holotype of *Lepidopa richmondi* (cl. 8 mm) USNM 29018 is from Greytown, Nicaragua.

Distribution:

Nicaragua: Greytown (type locality; Holthuis, 1960: 31, USNM 29018).

Haiti: Ile de Vache (Gordon, 1938; Holthuis, 1960: 31; USNM 65879).

Brazil: Caioba, Estado do Parana and Ithanhaen, Estado do Sao Paulo (Mendes, 1945: 124). Rio de Janeiro (CUM coll. Reinhardt). Rio Parahyba, Estado do Rio de Janeiro (MCZ 13229). Ipanema, Estado do Rio de Janeiro (USNM 56698). Praia Grande, Estado de Sao Francisco (Holthuis, 1960: 31). Vitória, Estado de Sao até Paranás (Da Costa: 1962).

Puerto Rico: (Holthuis, 1960: 31; USNM Acc. No. 134869).

Jamaica: Green Bay, St. Catherine's, Kingston (IEE 74).

Barbados: Belliplaine (IEE 91), (Morgan Lewis Beach IEE 201).

Columbia: Beach at Boca Grande, Cartegena, Dept. Bolivar (TU 4928).

St. Eustatius: Oisnji Baai, off Zeelandia Baai (RMNH 14636 and 14634).

Venezuela: Bordones Beach, near Cumana, State of Sucre (USNM Acc. No. 271794).

Trinidad: East of Sans Souci (IEE 200).

St. Lucia: Anse de Sables (IEE 202).

Gordon (1938: 188) quoted information provided by Dr. Schmitt to the effect that *richmondi* occurred in collections taken from Pensacola, Florida. In examining the material in the USNM I could find no material that would support this record and it must be assumed that it was a mistake unless material turns up from this same area in the future. Holthuis (1960: 33) states that Mendes (1945) recorded *fernandesi* from both Matinhos and Guaratuba in Brazil but I can find no evidence of these locality records in Mendes paper and, although the species does probably occur in those areas at the moment, the locality records are not valid for the species.

Description: Carapace wider than long; lateral spine region considerably wider than rest of carapace and from there edges curving in quite

sharply to waist about one-third of way back; another wide area present about one-third from posterior end from where straight sides converge towards truncated posterior end; posterior concavity shaped more like half an ellipse than a semicircle; rostrum (Fig. 2 a) triangular with rounded tip, very gently concave sides; ocular sinus smoothly rounded, curving gently into rounded convex area of about same size and shape as sinus itself, separating sinus from anteriolateral lobe; from anteriolateral lobe edge running almost directly out and back to lateral spine; spines themselves not very conspicuous, not projecting forward level with anterior edge; sharply pointed anteriolateral spines and subrostral spine present, groove around posterior edge of carapace continuous all round posterior concavity and lined with inconspicuous setae where it rounds middle of concavity; in both these characters the species differs from all other known members of the genus; setal pattern on carapace a little more elaborate than basic *Lepidopa* pattern as there are a few areas of setae and grooves behind central line.

First abdominal somite (Fig. 1 e) as long as broad, narrowing towards anterior edge; exposed region just a short curved line of setae; second abdominal somite with large rectangular wing-like pleural expansion, both anterior and posterior corners being very similar and rounded right-angles; anterior edge of expansion straight, sloping just slightly forwards; emargination in anterior edge of segment deep, over half as deep as segment itself at that point, with parallel sides; third and fourth segments with definite emarginations in anterior edges of their pleural expansions, and with the usual rows of setae found in the genus; fifth segment almost twice as wide at anterior end as at posterior end, pleural expansions thin, narrow, curving first backwards, then forwards; sixth segment just a little shorter than wide. Telson pear-shaped, a little longer than wide.

Eye-plate (Fig. 3 d) of *richmondi* almost square with rounded corners, eye-spot and cornea one-third of way from distal end on outside edge; distal edge and corners lined with evenly spaced teeth and long setae that almost equal length of plate; both upper and lower surfaces smooth and shiny, lacking setae except around edges. Third segment of antennule wider than in many species (about 2.5 times as long as wide); first flagellum very long and flexible; second reaching only to end of second article of first flagellum and made up of 3 articles (range 1—3). Antennal scaphocerite twice as long as broad; fifth segment long and thin, more than twice as long as wide; flagellum with eight articles (range 8—11), second to fifth having definite expanded distal ends, last article cylindrical, about as long as penultimate article.

Mandible with three-segmented palp and long sharp cutting edge, three teeth in a row at proximal end, two blunt ones back from edge, a sharp one right on edge, and two sharp teeth on edge at distal end. Second maxilliped with exopod of two segments, second rather short and thin, only about one quarter the length of first segment. Carpal expansion of third maxilliped (Fig. 4 k) just reaching to end of propodus; exopod thin and round in cross section, reaching about half way along merus.

Subchelate first pereopod and fourth pereopod resembling others in genus (Fig. 6 and 7). Dactylus of second pereopod with distinct, rather wide notch on one side (Fig. 6 l). Dactylus of third pereopod with rather wide based process, differing from others especially in *venusta* group in this respect (Fig. 6 u). Fifth pereopod chelate, possessing clear genital pore in some specimens that also carry a female genital pore on third pereopod. This occurs even in rather small individuals which one might imagine to be males and suggests that protandry occurs (e. g. ♀ and ♂ pores open in a specimen with cl. 5 mm. HEE 74).

Remarks: *Lepidopa richmondi* is clearly separable from all other species in the genus because it possesses a groove running right around the posterior edge of the carapace and this groove is lined with setae in the centre. The emargination in the anterior edge of the second abdominal segment is rather distinct in being so deep and having parallel sides although in a few animals the sides slope inwards.

The largest female recorded has a cl. of 15 mm. All specimens have been collected in the immediate beach area and there are no records from deeper water. In Kingston Harbour, Jamaica the species occurs in 30 cm or so of water just below the narrow zone which is crowded with the small sand crab, *Emerita portoricensis*. It seems very probable that it is feeding on the *Emerita* either when they leave the narrow (two meter wide) wash zone or *Lepidopa* may actually move up into this zone to feed. This feeding is probably at night as I have not seen *Lepidopa* active during the daytime on the beaches where I know the genus occurs.

One female collected on the 8th July at Boca Grande near Cartegena was carrying a sperm ribbon attached near to the female genital pore. Other than this information nothing is known about the breeding or biology of this species.

Lepidopa haigae sp. nov.

(Fig. 1 d, l; Fig. 2 e; Fig. 3 b; Fig. 4 j, i; Fig. 5 m; Fig. 6 j, s; Fig. 7 h)

Type: Holotype 12 mm cl. AHF 3924.
The species is named after Dr. Janet Haig.

Distribution:

The single specimen was taken from Chacahua Bay, Mexico on the 29th March, 1939 by Velero III (sta. 927—39).

Description: Carapace considerably wider at anterior end than elsewhere, longer than broad; behind lateral spines, carapace curving sharply inwards to waist, then outwards again to about one-third from posterior end, then narrowing to truncated posterior end; posterior concavity deep, more triangular than semicircular; groove around posterior edge paralleling edge of concavity, almost meeting in centre (Fig. 2 e). Rostrum triangular with sides slightly concave, tip a blunt point; no clearly defined anteriolateral lobes present (Fig. 2 e); from outer edge of ocular sinus, anterior edge of carapace running straight sideways and slightly forwards to what would normally be

outside edge of anteriolateral lobes; from this position edge running with gentle curve back to lateral spines; subrostral and anteriolateral spines absent; lateral spines are not well developed, entire anterior edge lined with short blunt teeth and long setae, extending almost right over eye-plates; carapace almost bare of more than basic setal pattern which is in rather shallow grooves lined with inconspicuous setae; some setal pattern behind central line.

First abdominal somite longer than broad, narrower at anterior end (Fig. 1 d); exposed portion a very small area of setae but no crescent-shaped region present; pleural expansions of second segment very large with slightly concave anterior edge, both anterior and posterior corners forming rounded right-angles; concavity in middle of anterior edge very narrow and deep, sides almost parallel (Fig. 1 d); third to fifth pleural expansions narrower, anterior edges concave; two rows of setae lining anterior edge of third and fourth expansions, one lining posterior edge of fourth expansion; fifth abdominal segment almost twice as wide at anterior end as at posterior end; sixth segment almost square with slight narrowing at posterior end. Telson nearly round.

Eye-plate (Fig. 3 b) almost square, slightly broader than long, with distinct cornea and eye-spot (pigment) near distal end on outside edge; distal edge and associated corners lined with a row of distinct regular teeth between which arise long setae over half length of plate itself; upper surface of plate smooth and shiny; lower surface with only one small clump of setae on proximal end near outside edge of plate.

Antennule with large saddle-shaped basal segment; third segment compressed at distal end, narrowing sharply to thin proximal end; first flagellum broken but with more than 52 articles; second flagellum with only one, thin, article reaching as far as base of third article of first flagellum. Antennae with sharp spine on corner of laterally compressed first segment; flagellum with eight articles, last two being cylindrical, second to fifth wider at distal end; last article longer than seventh. Mandible with three-segmented palp with long, undivided cutting edge as found in *distincta* (Fig. 5 e). Second maxilliped with two-segmented exopod, second segment very long and thin. Third maxilliped with carpus expanded over propodus as far as end of segment but not overlapping junction with dactylus; dactylus short, less than half as long as propodus; exopod single, long and thin; whole of maxilliped covered with fine long setae.

Subchelate first pereopod similar to others in genus. Second pereopod (Fig. 6 j) with carpus expanded as in third pereopod but not covered with setal mat as in the latter case. Dactylus of third pereopod possessing large, curved triangular shaped process near base (Fig. 6 s). Fourth and fifth pereopods not unusual, pleopods long, thin, extended forward below pereopods.

R e m a r k s : *Lepidopa haigae* is the most distinctive member of the genus and the only one that lacks the anteriolateral lobes and their two terminal spines which usually flank the ocular sinuses. The species closely resembles other members of the *benedicti* group in the shape of the eye-plate, which is slightly broader and shorter than in the other species in the group. The setae

lining the distal edge of the plate are proportionally longer, over half the length of the plate, than in other species in the group. The groove around the posterior edge of the carapace is almost identical to that found in *mearnsi;* it parallels the edge of the posterior concavity right around except for a short interruption in the middle. The shape of the groove suggests that *haigae* is more closely related to the *mearnsi-richmondi* pair, but in lacking a subrostral spine it resembles the *benedicti-deamae* pair. The distinct difference between this species and the others in the group suggests that the separation of *haigae* might have occurred earlier than the separation of the trans-American pairs.

The holotype was dredged in 20 to 30 m of water. Nothing is known about the biology of the species.

Lepidopa venusta Stimpson

(Fig. 3 p; Fig. 4 l, t; Fig. 5 e, k; Fig. 6 h, p; Fig. 7 b)

Lepidopa venusta Stimpson, 1860, Ann. Lyc. Natur. Hist. New York, 7: 79; (The name was first used by Stimpson, 1858, Proc. Acad. Natur. Sci. Philadelphia: 230 but is invalid in the original publication as there was no description); Miers, 1877, J. Linn. Soc. London, Zool., 14: 332; Ortmann, 1896, Zool. Jahrb. Abt., Syst., 9 (2): 226; Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 892, fig. 2; Schmitt, 1935, Sci. Sur. Porto Rico and Virgin Ids., New York Acad. Sci., 15 (2): 210, fig. 70; Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 188, fig. 1 a and 2 b; Margarida and Gomes, 1965, Rev. Brasil Biol. 25 (1): 97—103, fig. 1—9.

Type: No type material remains from Stimpson's original material, presumably it was lost with the other material in the Chicago fire. The absence of a type specimen for this species is particularly unfortunate for two reasons. In the first place the species has been confused with *websteri* and is in fact closely related to this other Caribbean species, but more important the species was selected by Holthuis (1962: 127) as the type species for the genus. For both these reasons I think that it is necessary to select a neotype. The only collection which contains material from the original type locality, St. Thomas, West Indies, is the one in the ZMK collected Buse and as this collection fits the original description of *venusta*, comes from the same locality, and as no other species has ever been recorded from that particular island, I select this female as the neotype of *Lepidopa venusta*.

Distribution:

St. Thomas, Virgin Ids., (Type locality: ZMK coll. Buse).

St. Lucia: (Holthuis, 1960: 31; BMNH 1890.10.7.152—5).

Trinidad: (BMNH 1950.12.28.6).

Columbia: Savanilla (Benedict, 1903: 892; USNM 7573).

Brazil: Praia Domingo Domingues, Sao Paulo; Ilha do Pai, Baia de Guanabara.

Holthuis (1960: 31) suggested that Gordon's *Lepidopa* sp. from St. Lucia, Peru (1938: 188, fig. 1 a) was actually *L. venusta* from St. Lucia, West Indies. My own examination of this material (BMNH 1890.10.7.152—6) confirms Holthuis' determination and to support the view that this material is not from Peru is the fact that the original label has had the word "Peru" added in pencil. It is persumably this pencilled addition which is incorrect and the label should read "St. Lucia" meaning the island in the West Indies. A second problem of distribution is the record of *venusta* from Tampa Bay, Florida (Schmitt, 1935: 210; Holthuis, 1960: 31). The collection USNM 49117 is from Tampa Bay Florida and originally was determined as *venusta* by Miss Rathbun, but actually contains specimens of *websteri*.

Description: Carapace wider than long, narrowing slightly behind lateral spines, with waist about one-third from anterior edge, widening again to just half way from front before narrowing to truncated posterior edge; posterior concavity semicircular; groove around posterior edge stopping just before reaching concavity; rostrum triangular, quite pointed; ocular sinus shallowly concave, running smoothly on to a gently convex region between sinus and anteriolateral lobe; from lobe, edge running only slightly backwards, then straight out towards lateral spine, there turning back to meet the rather small lateral spine; most of anterior edge, except rostrum, lined with very small rounded teeth; edge lined with long setae; setal pattern on carapace is just the minimum *Lepidopa* patterning as in others of *venusta* group (e. g. *esposa* Fig. 1 o); no patterning occurs behind central line; setae all over carapace short and inconspicuous.

First abdominal segment shorter than long, narrowing towards anterior edge; exposed area gently crescent-shaped, anterior edge lined with setae; second abdominal segment with large pleural expansion differing from most species because the slightly concave anterior edge slopes both sideways and backwards (Fig. 4 t); emargination in anterior edge wide and shallow; anterior lateral corners of pleural expansion almost right-angles, posterior corners forming broad curve; third and fourth segments with pleural expansions typical of others in genus (Fig. 4 t); fifth pleural expansion thin, curved forward at end; fifth segment widest at anterior edge, narrowing to nearly half the width at posterior edge; sixth segment almost square with slight widening along posterior end. Telson about 1.25 as long as wide and pear-shaped with bluntly rounded end.

Eye-plate (Fig. 3 p) longer than wide, almost elliptical; distal end with slight notch, suggesting a corneal site; dorsal surface of plate smooth and shiny, lacking setae except for a few in a row in proximal corner of outer edge; most of edge fringed with long setae attached to lower surface of plate; ventral surface of plate with considerable setal covering.

Antennule fairly typical of genus, third segment quite long and narrow, the almost parallel sides tending to converge slightly towards distal end from about one-third from proximal end; first antennule flagellum long, flexible, with 105 to 110 articles; second with two articles extending to end of second article on first flagellum. Antennal scaphocerite short, just overlapping base of fourth segment by about half its own length; antennal flagellum with 7 or 8 articles, all except very small first and long cylindrical terminal one being wider at distal end; terminal article much longer than penultimate one.

Mandible with three-segmented palp, and like others in *venusta* group, main cutting edge divided by tooth into short distal end and long proximal section (Fig. 5 e). Exopod of second maxilliped with two segments, second one very long (Fig. 5 k). Third maxilliped with expansion of carpus relatively short, not extending all the way over propodus; dactylus also short, only just longer than width of distal end of propodus; exopod about half as long as merus; whole of maxilliped very setose.

First pereopod subchelate, typical of genus; fifth chelate. Dactylus of second pereopod with cleft between bulge and distal end forming a "V" shape notch (Fig. 6 h). Long process near proximal end of dactylus of third pereopod like that in *mexicana* (Fig. 6 m), narrowing all along its length and in this differing from *chilensis;* carpus greatly expanded, setose. Dactylus of fourth pereopod narrower, longer, more pointed than in most other species (Fig. 7 b).

Nothing is known about the biology of this species. It has been collected rather infrequently, possibly because it lives in rather deeper water than most species, as Margarida and Gomes (1965) record the species from 20 to 30 m off the coast of Brazil.

Lepidopa mexicana sp. nov.

(Fig. 2 k; Fig. 3 s; Fig. 4 o; Fig. 5 f, i; Fig. 6 f, m; Fig. 7 e)

Type: Holotype ♀ cl. 9 mm, width 11 mm USNM 62384; paratypes ♀ cl. 8 mm, ♀ cl. 7 mm USNM 122634 (From same collection as holotype); paratype ♀ cl. 7 mm (ZMK); paratype ♀ cl. 8 mm AHF 638 (From IEE 55).

The specific name is a noun in apposition.

Distribution:

Mexico: South side of Zihuatanejo Bay, North of Acapulco (IEE 55); Teacapan, Sinoloa (USNM 62384; type locality). Costa Rica: Puntarenas (ZMK).

Description: Carapace wider than long, almost equally as wide between lateral spines and about one-third from posterior end, narrowing slightly between these two; behind second widening, edges sloping inwards, then meeting posterior edge which runs straight across body; posterior concavity semicircular; groove around edge of carapace running parallel with posterior edge, bending slightly anteriorly when edge reaches concavity, then stopping, not following concavity round (Fig. 2 k); carapace with typical pattern of setae found in both *venusta* and *benedicti* groups, with no setal pattern behind central line; setae on carapace thin, and inconspicuous, contrasting with those in *myops* group; rostrum triangular with rounded tip, sides curved back into gently curved ocular sinus (Fig. 2 k); outside edge of sinus slightly convex; from anteriolateral lobes, edge sloping backwards and outwards, then running fairly straight for short way before curving back to join rather inconspicuous lateral spines, lateral spines not projecting forward near anterior edge of carapace, although in two paratypes (USNM 122634) they are more conspicuous and project almost to anterior edge; subrostral spine and two distinct anteriolateral spines present.

First abdominal somite definitely shorter than long, narrower at anterior end; exposed section very narrow, only slightly crescent-shaped, anterior edge lined with setae; second to fifth somites with pleural expansions, those on second broad, with slight concave, setose, anterior edge and anterior distal corner just slightly more than a right-angle; edge lined with rather fine setae; pleural expansion of third somite with definite concave anterior edge paralleled

by groove lined with additional setae; pleural expansions on fourth segment shorter with similar groove along both anterior and posterior edge; fifth segment narrowing towards posterior end, pleural expansions thin, directed ventrally, then laterally, terminating in group of long, fine, laterally directed setae. Telson broadly pear-shaped with rather blunt rounded end.

Eye-plate relatively large (Fig. 3 s), broadest about one-third of distance from proximal end; outer edge gently convex, inner edge strongly convex; from widest part, inner edge running almost straight down to rounded tip; upper surface smooth and shiny, lacking setae; edge lined with setae attached on underside of plate except those along straight distal part of inner edge which are attached to edge itself; no cornea or eye-spot present; ventral surface of plate with extensive covering of long "feathered" setae.

Antennule with typical basal segments of genus, very long thin flagellum with 110 to 115 articles, second flagellum with three articles extending to end of second article of first flagellum. Antennal scaphocerite very short, flagellum with eight articles, distal end of second to seventh broad and rounded, proximal end narrow; eighth article cylindrical with rounded end, considerably longer than seventh.

Mandible with three-segmented palp, last segment longer than second; cutting edge divided into two sections by distinct corner formed by a tooth (Fig. 5 f). First maxilliped with second segment of exopod long and curved (Fig. 5 i). Second maxilliped with exopod of two segments, second narrow, half as long as first. Third maxilliped (Fig. 4 o) with expansion of anteriodorsal end of carpus reaching almost to end of propodus but not overlapping junction with dactylus; dactylus only about half as long as propodus; exopod a single segment.

First, subchelate pereopod and chelate fifth pereopod resembling others in genus. Dactylus of second pereopod (Fig. 6 f), with its inner edge forming narrow acute angle, quite distinct from some other species (e. g. *panamaensis*, Fig. 6 g). Dactylus of third pereopod (Fig. 6 m) with long hook on inner edge nearly half way from proximal end, this hook narrowing all the way to tip (Cf. *chilensis*). Dactylus of fourth pereopod horn-shaped (Fig. 7 c) with widest part being proximal.

R e m a r k s : *Lepidopa mexicana* is one of two new species in the Pacific that fit into the *venusta* group. They have roundish eye-plates with setae attached to the ventral side of the plate. *Lepidopa mexicana* differs from the other new one, *esposa*, in having very large eye-plates with the distal medial side flattened and slightly undulating (Fig. 3 s). The eye-plates clearly narrow towards the distal end from about the mid-line and are longer than broad; both points separate the species from *chilensis*. The subrostral spine is present as in all members of the group.

This species has been found only on sandy beaches. Nothing is known of the biology.

Lepidopa websteri Benedict

(Fig. 1 b, k; Fig. 2 j; Fig. 3 r; Fig. 4 h, m; Fig. 5 g, i; Fig. 6 o)

Lepidopa websteri Benedict, 1903, Proc. U. S. Natl. Mus., 26 (1337): 892, Fig. 3; Hay and Shore, 1918, Bull. U. S. Bur. Fish. (for 1915 and 1916) 34: 415; Gordon 1938, Bull. Raffles Mus., Singapore, 14: 188; Pearse, Humm and Wharton, 1942, Ecol. Monogr. 12 (2): 185, Fig. 11; Williams, 1965, U. S. Dept. Interior Fish. Bull., 65 (1): 138, Fig. 114.

Lepidopa venusta, Kingsley, 1880, Proc. Acad. Natur. Sci., Philadelphia, 1879: 410; Schmitt, 1935, Sci. Sur. Porto Rico and Virgin Ids., New York Acad. Sci., 15 (2): 210 (part): Holthuis, 1960, Proc. K. Nederland Akad. Wet., Ser. C 64 (1): 31, nec. Stimpson 1860.

Albunea scutellata, Gibbes, 1850, Proc. Amer. Adv. Sci., 2: 187, nec. Fabr. 1793 and H. Milne Edwards 1837.

Type: The holotype of this species is now in the USNM (42214). The type locality is Fort Macon, Carteret County, North Carolina, U. S. A.

Distribution:

U. S. A. North Carolina: Fort Macon, Beaufort (type locality USNM 42214; Kingsley, 1880: 410; Pearse et al., 1942: 185; RMNH 14630; BLY). Beaufort (Gordon, 1938: 188; Pearse et al., 1942: 185; USNM 62783, 82146, 81968—81975). Bird Shoal near Beaufort (Pearse et al. 1942: 185). Drum Inlet near Beaufort (Williams, 1965: 139).

South Carolina: Charleston Harbour (Gibbes, 1850: 187; MCZ 867).

Florida: Tampa Bay (USNM 49117).

Mississippi: Ship Id., (USNM 92432) to Petit Bois Id., (Williams, 1965: 139).

Description: Carapace considerably shorter than wide, with typical narrowing just behind lateral spines, then a widening before sides converge towards truncated posterior edge; posterior concavity just short of being semicircular (Fig. 2 j); groove around posterior edge stopping at concavity with end turned just slightly forward; rostrum a distinct, pointed pyramid with concave sides running back into ocular sinus; from base of sinus, edge running almost straight out to anteriolateral lobe with only slightest tendency to convexity where in most other species there is a definite bulge (Fig. 2 j); this is the easiest character separating *venusta* from *websteri;* from anteriolateral lobe, edge running back and outward, then running straight for some way before curving around to lateral spines; setae pattern on carapace the bare minimum found in the genus with no patterning behind central line and with many of the grooves appearing to lack setae until closely examined.

First abdominal segment shorter than long, narrowing towards concave anterior edge (Fig. 4 b); exposed section a thin line of setae with no crescent-shaped area behind; second abdominal segment with fairly deep, wide emargination, sides almost parallel; pleural expansion very large, slightly concave anterior edge sloping somewhat backward but no as much as in *venusta;* another difference is that the lateral and posterior corners of the expansion form one continuous curve in *venusta* whereas in *websteri* the lateral edge is straight; pleural expansion on the third segment typical of *Lepidopa* but anterior edge of fourth quite straight, sloping slightly forwards whereas in *venusta* it is not as straight and slopes backward (Fig. 4 l and m); fifth segment wider at

front and narrows; pleural expansions fairly thin, curving forward; sixth segment a little longer than broad. Telson pear-shaped, as long as wide.

Eye-plate of *websteri* (Fig. 3 r) very similar to that of *venusta*, both being longer than broad and almost elliptical, only differing in that *websteri* is proportionally a little wider, inside distal edge slightly flattened whereas in *venusta* it is convex all the way round; *L. websteri* also lacks small notch in distal end of plate found in *venusta;* upper surface smooth and shiny, lacking setae except in outer proximal corner; lower surface with large number of long setae; edge fringed with setae almost all attached to underside of plate except a few along middle of inner edge.

Flagellum of antennule of *websteri* probably longer, thinner and more flexible than in any other species; for example, one female cl. 8 mm had a flagellum 45 mm long and consisting of 172 articles; second flagellum with two articles and reaching just to end of first article of first flagellum (Fig. 1 k); third segment of antennule quite long and narrow being about four times as long as wide. Antennal scaphocerite short, just overlapping fourth segment; fifth segment only about half width of distal end of fourth segment, about twice as long as wide; flagellum with eight articles, second being longest, eighth about one and a half times as long as seventh and rather thin.

Mandible differing considerably from *venusta* in relative size of teeth; in *websteri* more proximal tooth on edge largest, cutting edge running straight from there to distinct angle where second tooth situated (Fig. 5 g). Second maxilliped with two-segmented exopod, second segment very long and thin. Third maxilliped with carpus expanded but not extending right to end of propodus.

First subchelate pereopod similar to others in genus. Second with dactylus similar to that in *venusta* (Fig. 6 h), but cleft narrower, bulge more hooked with definite concavity along outer edge. Dactylus of third and fourth pereopods resembling those in *venusta* although gap between hook and ancillary process in third pereopod slightly narrower and less broad in *venusta* than in *websteri* (Fig. 6 o).

Remarks: More is known about the biology of this species than any other member of the genus. Pearse, Humm and Wharton (1942) collected a number of specimens from the Beaufort region of North Carolina and found ovigerous females between 10—22 July. The young zoeae are found in the plankton off North Carolina in July and August (Williams 1965). The young individuals arrive on the beach sometime in the first half of August and probably overwinter as small individuals and grow up to adults in the spring of the following year. The adults live in the sand just below low-tide mark on exposed sandy beaches on open sea coastlines but in a few cases they have been recorded from some of the less exposed coastlines in the Beaufort region (Pearse et al. 1942: 185). The largest female was 13 mm cl. and the largest male 6 mm cl.

Lepidopa chilensis Lenz

(Fig. 3 n, o; Fig. 4 i, r, s; Fig. 5 h, l; Fig. 7 j)

Lepidopa chilensis Lenz, 1902, Zool. Jahrb., Suppl., 5: 750, pl. 23, Fig. 5 and 52; Dana, 1852, U. S. Explor. Exped., 1838—42, 13 (Crustacea 1): 406. There is some doubt as to the identification of this specimen and its present whereabouts: Rathbun, 1911, Proc. U. S. Natl. Mus., 38 (1766): 595; Porter, 1915 a, Rev. Chilena, Hist. Nat., 19: 82; Porter, 1915 b, Bol. Mus. Natl. Chile, 8: 17; Gordon, 1938, Bull. Raffles Mus., Singapore, 14: 188; Haig, 1955, Lund Univ. Arsskr. (n. ser.) Sec. 2, 51 (12): 11; Holthuis, 1960, Proc. K. Nederland Akad. Wet., Ser. C, 64 (1): 28.

Type: The holotype is a female cl. 11 mm in the Berlin Museum. According to Gruner (in Holthuis 1960) the specimen is in poor condition. I have not examined the type. The type locality is Iquique, Province of Tarapaca, Chile.

Distribution:

Chile: Iquique, Province of Tarapaca (type locality); Curaumilla, Province of Valparaiso (Porter, 1915 a: 82).

Peru: El Paraiso near Huacho (Holthuis, 1960: 28; RMNH 14632); Ancon (Holthuis, 1960: 28; BMNH 14633; BMNH 1913.12.10.128); Mollendo (Holthuis, 1960: 28; BMNH 1938.4.415); Lurin (Holthuis, 1960: 29).

Description: Carapace slightly wider than long, narrowing from widest point between lateral spines for about a quarter of length before widening again to about two-thirds back, then narrowing to truncated posterior end; posterior concavity quite shallow, just a little flatter than semicircular; groove around posterior edge stopping at edge of concavity with end turned slightly forwards; setae pattern as in *esposa* (Fig. 4 o), consisting of just simplest part of *Lepidopa* pattern with no extra areas of setae and no patterning behind central line; setae on carapace small and inconspicuous; rostrum triangular with concave sides, rounded tip; sides curving gently round to ocular sinus and outwards to gently curved convex section between sinus and anteriolateral lobe; from lobe, edge curving backward and outward, then running straight for some distance before curving around to long lateral spines; edge lined with very small teeth, difficult to see in some parts, and long setae; long anteriolateral spines and subrostral spine present (Fig. 4 r, s).

First abdominal somite shorter than wide, narrowing at truncated, slightly concave, anterior end; exposed part forming narrow flattened crescent-shaped area lined along edge with setae; pleural expansion of second abdominal segment wide, anterior edge almost half as deep as segment at that point, sides almost parallel; pleural expansions on third and fourth segments typical of genus; those on fifth segment flattened, curved forwards; fifth segment narrowing towards posterior end; sixth almost square but flairing out slightly right at posterior edge. Telson pear-shaped but only just larger than broad.

Eye-plate almost round (Fig. 3 n, o) with slight flattening along distal edge; edge lined almost all way round with setae, but except in proximal outer corner these setae attached to underside of plate, not to edge itself; distal half of underside of plate covered with mat of long setae, some also present along outer half of proximal edge; no eye-spot or cornea present.

No spine present on basal segment of first antennule, third segment narrow at proximal end, widening to about one-third along its length, then edges converging slightly all the way to distal end; first flagellum very long with about 100 articles; second flagellum with two or three articles and reaching as far as end of second article of first flagellum. Antennal scaphocerite very short, just reaching to base of fourth segment; flagellum with eight articles, second to fifth wider at distal end; last article cylindrical, almost twice as long as seventh.

Mandible (Fig. 5 h) with three-segmented palp, cutting edge divided up by tooth just to distal side of middle of edge, as in *mexicana* (Fig. 5 f). Second maxilliped (Fig. 5 l) with two segments to exopod where second segment very short, contrasting markedly with certain other species. Third maxilliped with carpus expanded over propodus to junction with dactylus but not overlapping junction; propodus with anterior dorsal expanded, overlapping dactylus; exopod round and thin, reaching about half way to end of proximal propodus (Fig. 4 i).

First and fifth pereopods like others in genus. Second and third with dactyla similar to those of *deamae* and *mexicana* respectively except distal process on third dactylus slightly expanded half way along its length whereas in *mexicana* and *wollebaeki* it narrows along its entire length. Fourth pereopod, with process on dactylus pointed, not rounded (Fig. 7 j).

Remarks: In addition to the material described above there is a female from Ancon, Peru (BMNH 1913.12.10.128) which differs slightly in both the eye-plate shape and in the rostrum being truncated rather than pointed (Fig. 3 o). As no other differences could be found between this specimen and other *chilensis* it seems probable that this specimen is just a variant within the species. More material from the same location may show that this is in fact a new species.

The basic differences between this species and others is the shape of the eye-plates and the expansion of the anteriodorsal end of the propodus of the third maxilliped. In other species the propodus end slopes backward or at most protrudes slightly as in *mexicana*.

Lepidopa esposa sp. nov.

(Fig. 1 o; Fig. 2 i; Fig. 3 q; Fig. 4 e; Fig. 7 g)

Type: The holotype is a male cl. 9 mm in the MPHN.

The specific name is a noun in apposition derived from the Spanish word for wife.

Distribution:

A single specimen of this species was found in the MPHN with a label which read "*Lepidopa myops* Stimps., Bouvier det., Basse California, Diguet 1905, Baiae de la Paz". The type location is therefore La Paz Bay, Baja California, Mexico.

Description: Carapace 11 mm wide, 8 mm long (Fig. 1 o), narrowing behind lateral spines to waist about one-third of length back, then widening

again for next third before narrowing to truncated posterior end; posterior emargination roughly semicircular in shape (Fig. 2 i); rostrum triangular with tip rounded; ocular sinus smoothly concave, outside edge running almost straight out to lateral lobes with only slight convexity (Fig. 2 i); in this particular character the species resembles *websteri;* from anteriolateral lobe, edge curving gently back and outward, then running almost straight before curving back to lateral spines; these lateral spines not very large, groove running back from spine very straight; long anteriolateral spines and long subrostral spine present, anteriolateral lobes lined with very small teeth; setal pattern on carapace resembling others in *venusta* group in being just the minimum *Lepidopa* pattern with very inconspicuous setae; groove along posterior edge of carapace stopping at posterior emargination (Fig. 2 i).

First abdominal segment shorter than long, narrowing towards front, anterior edge slightly concave; exposed portion just a very narrow curved band of setae; emargination in anterior edge of second segment nearly half as deep as wide, sides almost parallel; anterior edge of pleural expansion very slightly concave, sloping backward just slightly; anterior lateral corner a right-angle, posterior corner broadly rounded; third pleural expansion with anterior edge concave but same edge in fourth expansion straight, as in *websteri;* their setal grooves same as in other species; fifth segment wider at anterior end, pleural expansions thin, narrow, curved forwards; sixth segment almost square with slight waist about one-third from posterior end. Telson pear-shaped, about as long as broad.

Eye-plate almost identical to that of *venusta* except slightly narrower at base, more rounded on outside distal corner; the two very difficult to separate except by direct comparison (Fig. 3 q); plate smooth, shiny, fringed by setae; a few attached to actual edge, except in outside proximal corner, most attached to ventral side which is covered with large number of long setae except in centre of plate.

Antennule typical of others in genus; third segment relatively long and thin, carrying long flagellum although actual length unknown as both are partially missing in the type; second flagellum short, with one article, only reaching to end of first article of first flagellum. Scaphocerite of antenna very short, little longer than broad, just overlapping fourth segment; fifth segment rather small, about half length of fourth segment; antennal flagellum broken in both cases.

Mandible with three-segmented palp, long cutting edge unbroken by central tooth towards distal end. Exopod of second maxilliped with two segments, second very short, little longer than width of distal end of first. Expanded anterior end of carpus of third maxilliped not reaching to end of propodus (Fig. 4 c); dactylus short, exopod narrow, reaching only half way along merus.

First pereopod similar to others in genus. Dactylus of second like that of *websteri* with narrow notch quite unlike *venusta.* Dactylus of third pereopod more like *venusta* in that the two processes spread apart less, but the difference may be an individual variation. Dactylus of fourth pereopod (Fig. 7 g) similar

to that in *venusta* but distal end proportionally slightly thinner, proximal process more pointed with outer edge more concave, inner edge straighter.

Remarks: The process near the proximal end of the third dactylus has a definite thickening in the middle whereas in both *mexicana* and *websteri* this branch decreases in width throughout its length. The proximal bulge is definitely rounded in *mexicana*, more of a right-angle in *esposa* and bluntly pointed in *websteri*.

Nothing is known about the biology of *esposa*.

Lepidopa wollebaeki Sivertsen

(Fig. 4 h; Fig. 4 n; Fig. 8)

Lepidopa wollebaeki Sivertsen, 1934, Nytt. mag. natur. 74: 9–10, Pl. 4, Fig. 35—41.

Type: The only known specimen of this species is the holotype in the Zoologisk Museum, Oslo (F100) collected on the 24th August, 1923. This specimen is dry, shrivelled and partly fragmented, because of this our only knowledge of the shape of the carapace is Sivertsen's rather poor figure. The following is therefore, incomplete and deals mainly with characters which would allow us to separate *wollebaeki* from other species in the genus.

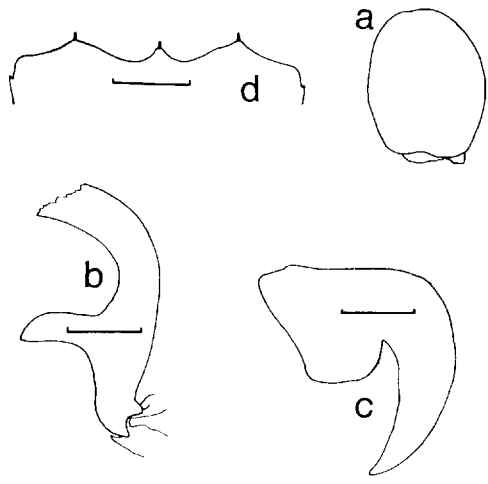

Fig. 8. *Lepidopa wollebaeki* (holotype). a) eye-plate dorsal view; b) dactylus of 3rd pereopod; c) dactylus of 2nd pereopod; d) anterior edge of carapace. Scale — 1 mm except d where it is 0.5 mm

Distribution:

Floreana, (Isla Santa Maria), Galapagos Ids., Ecuador.

Description: Carapace appearing longer than wide; anterior edge with triangular rostrum with concave sides, rounded tip, distinct subrostral spine; ocular sinus shallow, edge running out to anteriolateral lobes is just slightly convex; from anteriolateral spine, edge curving gently back and outwards, then running fairly straight for some way before curving slightly back to lateral spines; these spines distinct, projecting forward level with anterior

edge; small round teeth lining anterior edge of carapace from about mid-way between anteriolateral and lateral spines; lateral spine groove straight, lined with setae; posterior concavity in carapace seeming broad and shallow; groove around posterior edge of carapace not visible in holotype; carapace itself like others in *venusta* group, smooth, with minimal setae pattern.

First abdominal segment with short, flattened, crescent-shaped exposed portion at posterior edge, anterior edge of which being lined with setae (Fig. 1 h); second abdominal segment with broad concavity in anterior edge

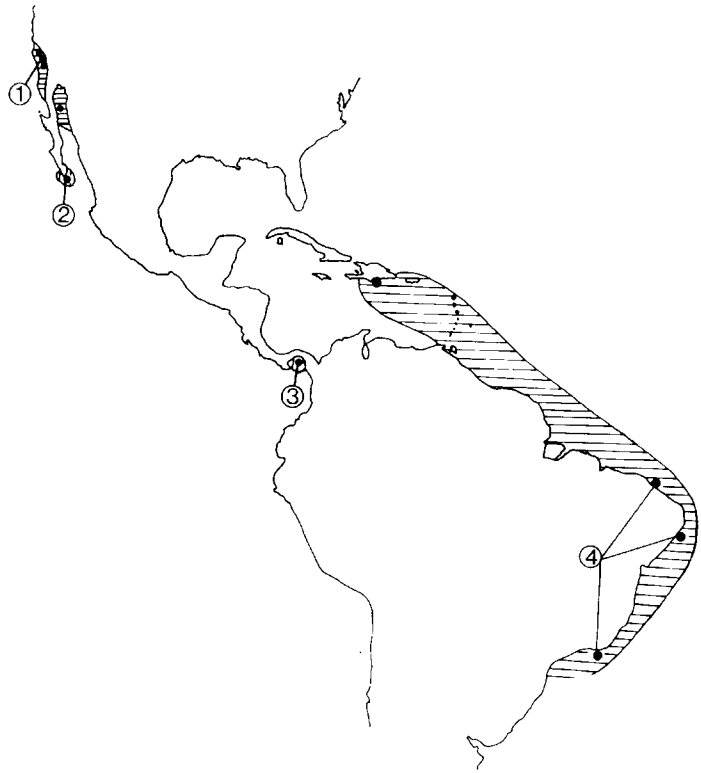

Fig. 9. *Lepidopa*. Distribution of the species in the *myops* group and *californica*. 1. *californica;* 2. *myops;* 3. *panamaensis;* 4. *distincta;* The type locality is indicated by the line from the number

with sloping sides, lateral expansions with straight anterior edge, anterior corner a rounded right-angle, posterior corner broadly rounded. Sixth abdominal segment just longer than broad with slight waist in middle. Telson larger than broad, pear-shaped.

Antennal scaphocerite very short, flagellum of seven articles, last one cylindrical, distinctly longer than penultimate article.

Eye-plate (Fig. 7 a) very similar to that in *chilensis* (Fig. 3 n) in being almost round, but differing in being just slightly longer than broad, in some ways resembling *websteri* (Fig. 3 r) but not flattened along one edge as in this latter species; distal edge very slightly concave as in *venusta* (Fig. 3 p).

Third maxilliped (Fig. 4 n) with carpus extending well over propodus but not reaching anterior edge; anterior end of propodus slightly expanded but more rounded than in either *chilensis* or *mexicana;* species resembling *esposa* (Fig. 4 c) in shape of this expansion.

Dactylus of second pereopod pointed with broad squarish expansion at proximal end (Fig. 8 c). Dactylus of third pereopod (Fig. 8 b) with proximal process narrowing all the way to distal end as in *mexicana* and in this differing from *chilensis.*

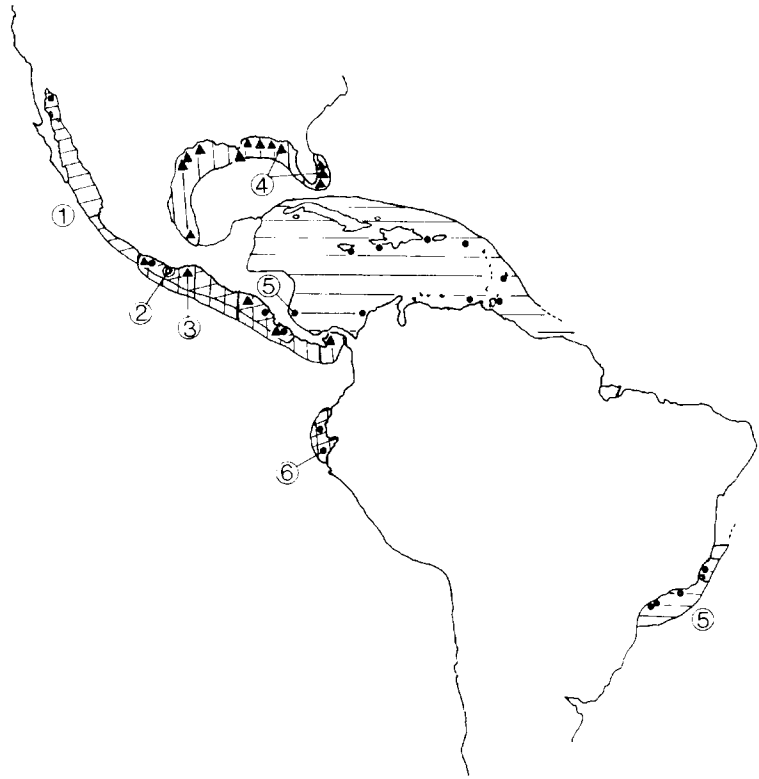

Fig. 10. *Lepidopa.* Distribution of species in the *benedicti* group. 1. *mearnsi;* 2. *haigae;* 3. *deamae;* 4. *benedicti;* 5. *richmondi;* 6. *sorodeamae.* The type locality is indicated by the line from the number, *mearnsi* does not have a specific type locality

Very few characters distinguish this species from *chilensis* to which it appears closely related, as indicated by the eye-plate. The distinguishing characters are (1) eye-plate not quite round — just slightly longer than wide. (2) concavity in anterior edge of second abdominal segment has sloping sides, not almost straight as in *chilensis.* (3) seven articles in flagellum rather than eight; this may be an individual variability. (4) expansion of the propodus of the third maxilliped slight and rounded. (5) process at proximal end of dactylus of third pereopod narrows all along its length.

Discussion

Our knowledge on the systematics and distribution of *Lepidopa* is now sufficiently detailed that some preliminary idea of the evolution of the group is possible. In presenting a tentative outline of the evolution within the genus I will rely on four major points. These are (1) The genus can clearly be divided into four groups — *myops, benedicti, venusta* and the single species, *californica;* (2) Some of the members of the groups form pairs of closely related

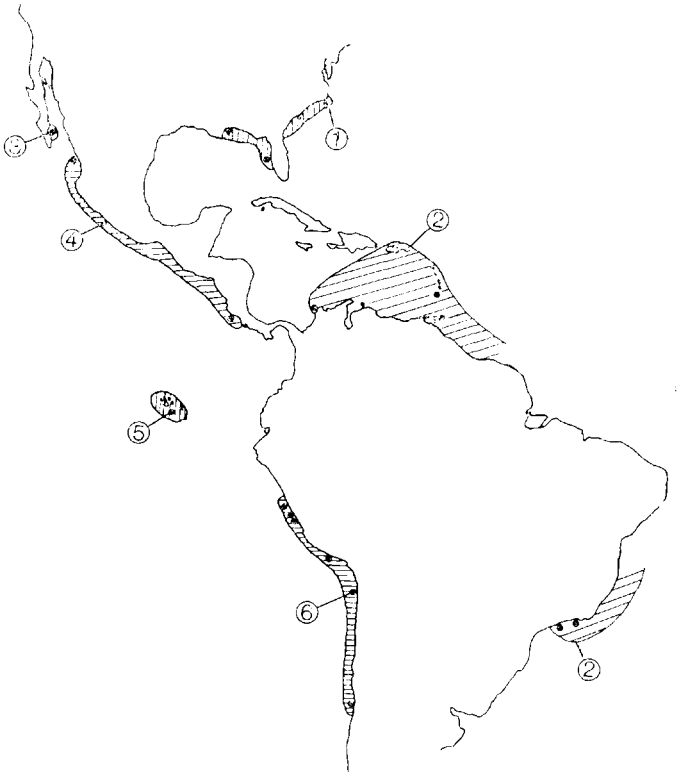

Fig. 11. *Lepidopa.* Distribution of species in the *venusta* group. 1. *websteri;* 2. *venusta;* 3. *esposa;* 4. *mexixana;* 5. *wollebaeki;* 6. *chilensis.* The type locality is indicated by the line from the number

species with one member of the pair occurring on each side of the Americas; (3) All the species that do not fit into a pair are found on the Pacific side of the Americas; (4) We know that no sea connection has occurred across Central America since the late Pliocene and it is improbable that there has been any exchange around Cape Horn both because the crabs are tropical or subtropical and because the two most southerly species, *chilensis*, on the Pacific side, and *richmondi*, on the Atlantic side, are not closely related. With these points it is possible to propose an evolutionary tree for the group and in doing so, to suggest the probable number of species alive in the late Pliocene.

The species pairs are summarised in Figure 12. This shows that there were probably six or seven ancestral species alive when the sea connection was broken and their populations were cut into two. Five gave rise to species pairs and a sixth gave rise to *californica*; possibly this one was already isolated somewhere along the north west coast of the Americas. The seventh species may have been *haigae* as it is quite distinct from all other *Lepidopa* and may have separated off earlier than the late Pliocene from the *richmondi-mearnsi* stock. These six or seven species probably arose earlier from two basic ancestors,

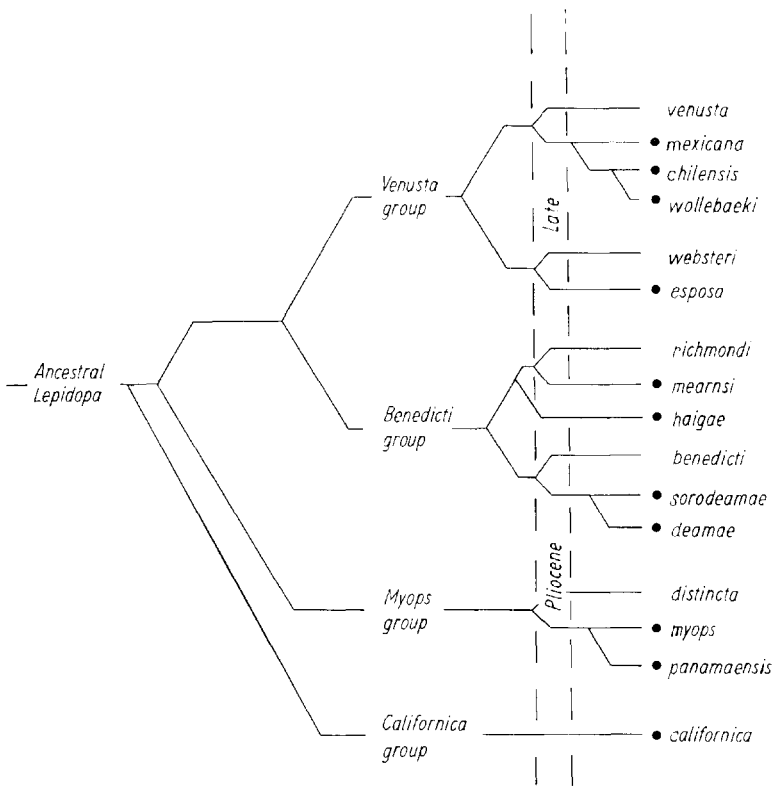

Fig. 12. *Lepidopa*. Evolutionary tree showing possible relationships of the species in the four groups of *Lepidopa*. Those marked • are Pacific species and the others are from the East coast of the Americas

one of which gave rise to the three species in the *myops* group and the other to the rest of the species in the genus. *Lepidopa californica* holds a somewhat anomalous position in that it has the eyes of the *myops* group but resembles the *benedicti* and *venusta* group in all other characters. It more closely resembles the *benedicti* group in the shape of the groove around the posterior edge of the carapace and in the lack of a subrostral spine; however, the eye-plate and the eye-plate setae resemble those in the *venusta* group. It probably separated early in the history of the genus from the common stock of the two groups and may have been geographically isolated since that time.

This leaves the problem of why there are so many extra species in the Pacific Coast. I feel that *wollebaeki* probably arose from *chilensis* whose pelagic larvae could easily have drifted from Peru to the Galapagos and become established there. The four species — *haigae, californica, myops,* and *esposa* are interesting in having restricted distributions near the Gulf of California. I think that changes in sea temperatures have resulted in part of the Gulf of California forming isolated pockets in which species have had time and the isolation to differentiate from their parent population. This pocket may be in the head of the Gulf, as now with the sub-population of *californica* and another sand crab *Emerita analoga* while the main population in both cases occurs along the outside coast of nothern Baja California and Southern California. Alternatively, it may be tropical "island" on the tip of Baja California itself where *esposa* and *myops* now live as does a population of another tropical sand crab, *Hippa pacifica.* With each pulse of the *isotherms* up and down this part of the coast of Mexico new species may bud off. The same type of process may be occurring at this present time on each side of Florida in the case of *websteri* and the sand crab *Emerita talpoida,* but at the moment I can find no morphological characters separating either of these two sub-populations.

In the case of *sorodeamae* and *chilensis,* the isolating barrier between the northern coast of South America and the coast from Ecuador south may be the current pattern. Possibly the southern section has been seeded regularly with changes in sea temperature and the subsequent changes have resulted in current patterns which prevent the mixing of species from the two sub-populations and resulting speciation (Efford, 1970).

In conclusion, it should be emphasized that these ideas on the evolution of the genus *Lepidopa* cannot be considered more than a preliminary hypothesis and need to be tested by more work on this genus, particularly by a comparison of the larvae. What is clear is that the genus *Lepidopa,* as we know it today, consists of a group of morphologically rather homogeneous species which are easily separated from other genera in the family.

Preliminary examination of pelagic larvae from the plankton of California and North Mexico (M. Knight, personal communication) suggests, that other species are present that we have not yet found as adults, as for example off California where two species of larvae are known in an area where only one adult, *californica,* has been recorded.

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