Small land snails from Northern Australia, III: Species of Helicodiscidae and Charopidae

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ABSTRACT

Two taxa of Indonesian origin and main distribution, the helicodiscid snail *Stenopylis coarctata* (Moellendorff, 1894) and the charopid *Discocharopa aperta* (Moellendorff, 1888), extend across northern Australia. They appear generally dispersed, reaching southern limits in the Napier Range and near Halls Creek, Western Australia; somewhat south of Alice Springs, Northern Territory; and then south to near Mackay, Queensland or into the north-eastern corner of New South Wales, respectively. Both species have been described several times. A second charopid, *Pilsbrycharopa tumidus* (Odhner, 1917), also is of New Guinea-Indonesian affinities. It has been recorded from a single collection on an island in the Fitzroy River on Noonkanbah Station, Western Australia. A third charopid, *Dupucharopa millestriata* (Smith, 1874) has been recorded once from Depuch Island, east of Roebourne, Western Australia. It has not been dissected, but shell features suggest that it also is of northern affinities. None of these appear to be closely related to any of the southern Australian charopid radiations.

INTRODUCTION

This is the third of a series of reports on small land snails from Northern Australia, based mainly upon materials collected during field surveys of camaenid land snails (Solem, 1979, 1981a 1981b, 1984). Previous reports in this series have reviewed *Gyliotrachela* Tomlin, 1930 (Solem, 1981c) and *Westracystis* Iredale, 1939 (Solem, 1982). This paper summarizes information about the single member of the Helicodiscidae found in Australia, the Indonesian to Solomon Islands *Stenopylis coarctata* (Moellendorff, 1894), and three charopid land snails of northern distribution and affinity. New illustrations and descriptions are given of all taxa.

Scanning electron microscope (hereafter SEM) photographs of shell, jaw, and radula provide evidence of unique structures permitting assignment of three species as being of northern affinities. Evidence concerning *Dupucharopa,* which has not been dissected,

is less compelling, but it also seems to be a relict from the north, rather than related to the major charopid radiations in southern Australia. The first anatomical data on *Stenopylis* (Figs 1-4) confirms its classification in the Helicodiscidae. *Discocharopa* has been reviewed elsewhere (Solem, 1983), and only abstracted coverage is presented below.

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SYSTEMATIC REVIEW

Family Helicodiscidae

Diagnosis: Shell under 5 mm in size, with few, flatly coiled whorls that do not increase rapidly in size. Umbilicus widely open, shallow. Sculpture of spiral ridges, often deciduous, reduced in some taxa. Aperture normally with barriers or nodules, sometimes deflected and/or thickened when adult. Pallial region with kidney reaching hindgut, rectal extension slight, ureter opening next to hindgut at posterior of pallial cavity. Ovotestis a single lobe, talon very elongated and without expanded head. Prostate and uterus apparently united into a spermoviduct. Epiphallus variable, with a separate retractor muscle, except in *Stenopylis*. Penial retractor muscle arising from diaphragm. Penis with or without verge and pilasters, with or without a lateral caecum. Radula with tricuspid central, reduced to very reduced in size, three to five tricuspid laterals, and several marginals that become shortened, broadened, and sometimes lose their cusps on the outer marginals.

The above diagnosis is altered from that presented by Solem (1975) on the basis of structures reported on for *Stenopylis* in this report. The Family Helicodiscidae still is considered to contain only the following genera: - *Helicodiscus* Morse, 1864 (including the subgenus *Hebetodiscus* H. B. Baker, 1929 and section *Pseudiscus* Morrison, 1942) and *Polygyriscus* Pilsbry, 1948 from North America, and *Stenopylis* from Indonesia, Philippines, New Guinea, Solomon Islands, and northern Australia. This disjunct distribution probably is an ancient one. The occurrence of relatives in southern and western China would not be surprising, but until that region has been better explored malacologically, the absence of such finds can be attributed either to lack of collecting effort or actual absence with equal probability.

The family name Helicodiscidae Pilsbry, 1927 was published in Baker (1927: 226, 230), and thus antedates the family name Stenopylidae Iredale (1937a: 26).

Genus *Stenopylis* Fulton, 1914

Stenopylis Fulton, 1914, Ann. Mag. Nat. Hist., (8) *14:* 163-164; Iredale, 1937, South Australian Nat., *18* (1-2): 26-27, pl. I, fig. 20; Iredale, 1937, Australian Zool., *9* (1): 1; Solem, 1957, Fieldiana: Zoology, *42* (1): 8-11.

Coarctatio Haas, 1945, Fieldiana: Zoology, *31* (2): 10-13, figs 1a-e, type species *Plectopylis coarctata* Moellendorff, 1894.

Diagnosis: A genus of Helicodiscidae with small parietal and palatal wall barriers when subadult, parietal barriers retained as ridges and blobs in adults. Shell shape and growth pattern typical, with wide umbilicus, low spire, and few whorls that barely increase in width. Spiral sculpture typical (Fig. 8). Lip grossly expanded, rolled, thickened, parietal section free of wall and extends outwards at a near right angle to provide a large shield to the aperture. Genitalia (Figs 1-3) with short ovotestis (G), no epiphallic retractor muscle, large penis caecum or epiphallus (E), uterus (UT) capable of enormous expansion by single embryo (Fig. 1). Radula (Figs 11-15, 17-21) with relatively large central tooth, few typical laterals, and outer marginals unusual in that all cusps are lost (Figs 11, 19, 20).

Type species. — *Planispira hemiclausa Tate, 1896.*

Comparative remarks and biology

Helicodiscus Morse, 1864 differs in its larger size, simple lip, very long ovotestis, and retention of cusps on the lateral teeth of the radula (Pilsbry, 1948: 624, figs 338A-D, 626, figs 339a-b). *Polygyriscus* Pilsbry, 1948 has a strongly deflected lip (Solem, 1975: 82, figs 2a-c) that is only slightly expanded, long periostracal extensions, very long ovotestis (Solem, 1975: 81, fig. 1a), the central tooth of the radula is very small and the marginal teeth retain prominent cusps (Solem, 1975: 83, figs 4, 6-8).

The combination of minute size, spiral ridges on the shell (Fig. 8), continuous lip with large barrier (Figs 6-7), widely open umbilicus (Fig. 7), and near absence of whorl width increment (Fig. 5), immediately separate *Stenopylis coarctata* (Moellendorff, 1894) from any other Indonesian or Australian taxa. The only species apt to be confused with it is the charopid *Discocharopa aperta* (Moellendorff, 1888), which is similar in size and umbilical width, but has radial shell sculpture (Figs 22-27), lacks both a raised parietal lip (Figs 23-24) and lip edge barriers (Fig. 24), and shows normal charopid whorl width increment (Fig. 22). Both genera are microsympatric throughout much of their ranges, normally with *Stenopylis* being much more common in collections. This phenomenon may be the result of sampling bias in favour of the larger *Stenopylis,* longer persistence of its shell after death (98% of known examples were collected dead), its occupying a shelter site more often sampled by collectors, or an actual lower level of abundance. Only additional field work can solve this problem.

All live collected material was in aestivation, and no specimens expanded fully during the preservation process. Probably a combination of the constricted aperture and narrow whorl profile delayed fixation of the snails. Many difficulties were encountered in attempting to dissect and interpret the anatomy. On two occasions, Elizabeth A. Liebman and I went into "training" by dissecting and illustrating progressively smaller and smaller punctids and charopids, working down in size to *Discocharopa* and *Stenopylis.* We were relatively successful with the former (Solem, 1983: 75, fig. 34), but in part frustrated by *Stenopylis (Figs. 1-4).*

A major difficulty involved interpreting the pallial genitalia. The largest specimens from Sta. WA-218 (near Kalumburu Mission, Western Australia, FMNH 200538, 28 October 1976) each contained one enormous embryo (Fig. 1), which looked, in gross dissection, as being barely capable of exiting past the apertural barriers. All organs in this section of the snail were flattened and pushed out of position, so that we were unable to

interpret structures in this region. Other specimens from the same set were very deeply retracted and the animal noticably smaller in size. A live specimen collected 29 August 1975 from the Napier Range (Sta. NR 5, WAM 806.76) showed no evidence of such embryos. Unfortunately, this specimen had been preserved in formalin, which makes dissection and study very difficult. Parts of the genitalia crystallize and become destroyed over a short period of time. Some additional features could be interpreted from this specimen (Fig. 3), but many features of the genitalia remain unknown. Subsequently, Fred and Jan Aslin collected a good set of live examples from Eurobra Gorge, north-east of Alice Springs, Northern Territory (FMNH 198861, 17 June 1978), a few of which partly expanded during preservation. Many adults in this sample also contained massive embryos, visible through the shell as occupying up to three-eighths of the body whorl. Slight expansion of the foot outside the shell during preservation shows that the "parent" was alive and well, despite its elephantine burden.

The presence of a single huge embryo in dry season examples has several implications. First, *Stenopylis* must live more than one year. Production of single young per adult is not a viable reproductive strategy, and dry season development of the embryo is indicated by these collections. The normal start of the wet season at Kalumburu is about November to early December, the same as at Napier Downs, and a month later than at the Mitchell Plateau. Embryo absence in August, and presence in late October suggest late dry season development. Since the Alice Springs area may have May to July rains in some years, embryo presence in June is not surprising.

Analysis of the Eurobra Gorge set also permits presenting some hypotheses as to the life cycle of *Stenopylis*. A total of 48 specimens were included. They can be grouped as follows: -

Juveniles, 0.9-1.05 mm in diameter, without internal shell barriers developed	6
Subadults, 1.13-1.38 mm in diameter, with internal shell barriers, but no lip expansion or lip barrier	10
Adults, 1.5-1.81 mm in diameter, lip fully expanded	32
No embryos, spiral sculpture unworn	8
Spiral sculpture worn, body large, no clear trace of embryos	7
Large embryos present, spiral sculpture worn	9
Large embryos present, spiral sculpture unworn	8

This suggests that there are two age classes of juveniles. The structure of the barriers in subadults is discussed below, but the two groups are easily separable visually. The range of measurements is misleading, since one large juvenile and one small subadult obscured clumped differences.

The adults can be divided on the basis of shell wear, and the presence or absence of embryos. I would interpret the lack of shell wear as indicating "became adult in last wet season" or "were very lucky in avoiding wear" during their last wet season. Species of the camaenid land snail genus *Semotrachia* Iredale, 1937 from near Alice Springs can routinely be separated into third wet season adult (male organs fully formed, female organs still undeveloped) and fourth or more wet season adults on the basis of periostracal shell sculpture wear (Solem, unpublished). Thus it is reasonable to

hypothesize that the worn adults of *Stenopylis* have been adult through at least one wet season. The worn adults without embryos could be either post-reproductive (= senile), or have recently given birth. Field notes by the Aslins' mention no rainfall in early June, but a March or April fall might have enabled successful reproduction. The presence of embryos in both worn and unworn adults also suggests more than one reproductive event for an adult.

The unworn adults without trace of embryos probably had reached maturity at the end of the previous wet season and would be reproductively active during the next period of rains.

While the above speculations are based upon analogy with the camaenid land snail reproductive cycle in the same regions, the presence of four distinct age classes among live individuals is strong evidence for a multi-wet season life cycle in *Stenopylis*. It is quite possible that in the Indonesia to Solomon Islands section of its range, where there is less marked periodicity of rainfall, that the life cycle would be altered. Certainly the above data on embryo size class variation indicate that this species is worthy of life history studies.

Study of diet would be equally interesting. The small size of *Stenopylis* and finding of live specimens mainly on the underside of damp rocks with abundant micro-flora suggests grazing on micro-flora, but the peculiar loss of cusps on the majority of the marginal teeth (Fig. 11) is not duplicated in any other land snail known to me.

Stenopylis coarctata (Moellendorff, 1894)

figs 1-8, 11-21

Plectopylis coarctata Moellendorff, 1894, Nachr.-Bl. deut. Malak. Gesell., *26* (7-8): 113 — Panglao, near Bohol, Philippine Islands (August); austino, 1930, Philippine Jour. Sci., *42* (1): 116.

Planispira hemiclausa Tate, 1894, Trans. Roy. Soc. S. Australia, *18*: 192 — central Australia (November).

Brazieria coarctata (Moellendorff), Moellendorff, 1895, Nachr.-Bl.deut. Malak. Gesell., *27* (9-10): 159; Moellendorff, 1898, Abhl. Naturf. Ges. Goerlitz, *22*: 123.

Brazieria coarctata var. *majuscula* Quadras *in* Moellendorff, 1895, Nachr.-Bl. deut. Malak. Gesell., *27* (9-10): 159 — Masbate, Philippine Islands.

Microphyura hemiclausa (Tate), Tate, 1896, Rep. Horn Exped. central Australia, Part II, Zoology, pp. 185-186, plt. 17, figs 1a-b, pp. 221-2, fig. C — Ilpilla Gorge, Spencer Gorge, Finke Gorge, Redbank Gorge, Palm Creek, Alice Springs, central Australia; Victoria River, Northern Territory; Bowen and Cardwell, Queensland.

Helix (Polygyra) microdscus Bavay, 1908, Nova Guinea, Zool., *5*: 283, plt. 14, figs 10, a-d — Humboldt Bay, New Guinea.

Stenopylis coarctata (Moellendorff) Fulton, 1914, Ann. Mag. Nat. Hist., (8) *14*:: 163-164 (lists *microdiscus* and *hemiclausa* as distinct species); B. Rensch, 1932, Zool. Jahrb., Syst., *63* (1): 103 — Sumba, Indonesia; B. Rensch, 1935, Sitz.-Ber. Gesell. Naturf. Freunde, Berlin, *1935*: 322 — Timor, Indonesia; van Benthem Jutting, 1941, Arch. Neerland. Zool., *4*: 300-301, figs 2-3 — satellite islands of Java, Indonesia; van Benthem Jutting, 1952, Treubia, *21* (2): 405-406, figs 68a-c; Solem, 1957, Fieldiana: Zoology, *42* (1): 8-11, figs 4a-e; Solem, 1958, Arch. Mollusk., *87* (1/3): 21; Solem, 1960, Jour. Malac. Soc. Australia, *4*: 43 — Florida Id., Solomon Islands; van Benthem Jutting, 1964, Nova Guinea, Zool., *26*: 10-11; Wilson and Smith, 1975, Western Australian Wildlife Research Bull., *3*: 99; Merrifield, Slack-Smith, and Wilson, 1977, Western Australia Wildlife Research Bull., *6*: 115.

Stenopylis hemiclausa (Tate), Fulton, 1915, Proc. Malac. Soc. London, *11*: 236; Iredale, 1937, S. Australian Nat., *18*: 26-27, plt. I, fig. 20; Iredale, 1937, Australian Zool., *9*: (1): 2.

Microphyura microdiscus (Bavay), Odhner, 1917, Kungl. svensk. Vetens. Handl., *52* (16): 99-100 — Chillagoe Caves, Queensland (on p. 114 synonymizes *microdiscus* and *hemiclausa* on authority of Charles Hedley).

Coarctatio coarctata Haas, 1945, Fieldiana: Zoology, *31* (2): 10-13, figs 1, a-e.

Microphyura nightingali Saurin, 1960, Jour. de Conchyl., *100* (1): 7-9, figs 3A-D — Bach Long Vi (= Nightingale) Island, Gulf of Tonkin, Vietnam.

Diagnosis: A minute species, adult diameter 1.4-1.8 mm, with nearly flat spire, whorls normally 3 1/2, at most slightly increasing in width, apex smooth (Fig. 5), rest of shell (Fig 6-8) with microscopic spiral cords, only radial elements representing growth pauses (Figs 7-8) at sporadic intervals. Lip strongly thickened and expanded, parietal section free of wall and projecting at right angles to form a shield-like extension across aperture (Fig. 6). The spiral sculpture, equal width whorls, and expansion of the parietal lip immediately identify this species. The often sympatric *Discocharopa aperta* (Moellendorff, 1888) (Figs 22-27) differs in having prominent radial sculpture and the whorls increase regularly in width, although agreeing in size and shape.

Material Studied: The following records of Australian material are organized geographically, roughly south to north, then west to east. Extralimital materials summarized by Solem (1957) are not relisted. Locality data covered by Wilson and Smith (1975), Merrifield, Slack-Smith and Wilson (1977), and Solem (1979, 1981a, 1981b, 1981c, 1982, 1983, 1984) have been abbreviated here to save space and minimize repetition.

WESTERN AUSTRALIA Port Hedland: limestone on north side of airport (22 dead specimens, WAM 4674.68, collected by Ted Atkins July 1965).

Napier Range, August 1975 (Sta. NR I-XXIV), May 1976 (NRII — 1-31), November 1976 (NRIII — 1-2), sequence north-west to south-east: 2 km from Red Bull Mill (8 dead specimens, WAM 374.81); north-west end of Napier Range — Sta. NR VII, NRII — 6 (2 dead specimens, WAM 379.81, WAM 947.76); near Barnet's Cave — Sta. NR IX (ca 61 dead specimens, WAM 804.75, WAM 805.75); north-west of Stumpy's Well — Sta. NR V, NR VI, NR IX (1 live, ca 16 dead specimens, WAM 806.76, WAM 808.75, WAM 811.76); 6.5 km north-west of Barker River Gorge — Sta. NRIII — 2 (13 dead specimens, WAM 377.81); near Kongorow Pool, Barker River (ca 70 dead specimens, WAM 365.81, WA, 380.81, WAM 383.81); Wombarella Gap — Sta. NRII — 7 (1 dead specimen, WAM 378.81); Windjana Gorge — Sta. NR XI (1 dead specimen, WAM 948.76); 15 km south of Windjana Gorge — Sta. NR XVIII (1 dead specimen, WAM 802.76); drift at mouth of The Tunnel (6 dead specimens, WAM 369.81, collected by G. W. Kendrick 26 August 1967).

Napier Range, October 1976 to May 1977: Sta. WA-336, 4.3 km south-east Carpenter Gap (1 dead specimen, FMNH 199279); Sta. WA-271, cliffs 11.3 km east Tunnel Creek turn-off (1 dead specimen, FMNH 199453).

King Leopold Ranges: 6 km north-east Mac's Jumpup (1 dead specimen, WAM 366.81, B. R. Wilson and S. Slack-Smith 28 August 1975); valley to north-east of Mt. Bell (4 dead specimens, WAM 373.81, B. R. Wilson and S. Slack-Smith 27 August 1975).

Prince Regent River Reserve, August 1974: eastern face of Mt. Trafalgar (15° 17' S, 125° 04' E) — Sta. W4 (1) (5 dead specimens, WAM 215.75); Pitta Creek, Prince Regent River (1 dead specimen, WAM 214.75).

Beverley Springs Homestead: Homestead-Gibb River Road (8 dead specimens, WAM 375.81, B. R. Wilson and S. Slack-Smith 27 August 1975).

Mitchell Plateau: Sta. 7, north side Walsh Point (8 live specimens, WAM 381.81, B. R. Wilson 30 October 1976); Sta. WA-204, Crystal Creek vine thicket (2 live, 13 dead specimens, FMNH 199570, FMNH 200389, FMNH 200392, FMNH 200426, FMNH 200429, A. Solem October 1976).

Admiralty Gulf: Baudin Island, Institut Islands (14° 08′ S, 125° 36′ E) (1 dead specimen, WAM 384,81); South West Osborne Island (ca 44 dead specimens, WAM 370.81, W. K. Youngson 28 June 1973).

Kalumburu Mission: Sta. WA-218, boab tree by banana patch (ca 30 live, ca 30 dead specimens, FMNH 199517, FMNH 200532, FMNH 200538, FMNH 200542-3, A. Solem October 1976).

Drysdale River National Park, late August 1975: Sta. C1-2, Worriga Gorge (Ashton 4267 — 491:376) (1 live, 7 dead specimens, WAM 100.76, WAM 101.76); Sta. C2-5, Woorakin Creek (Ashton 4267 — 571:346) (ca 62 dead specimens, WAM 102.76-104.76); Sta. C2 — 6, Woorakin Creek Gorge (Ashton 4267 — 565:345) (1 live, 3 dead specimens, WAM 105.76, WAM 382.81); Sta. C2 — 7, Woorakin Creek Gorge (Ashton 4267 — 555:341) (3 live, 18 dead specimens, WAM 106.76, WAM 107.76).

Pentecost River: Sta. WA-223, WA-592, flood plain of river on El Questro Station (15 live, ca 80 dead specimens, FMNH 200556, FMNH 200560, FMNH 200562, FMNH 204745-6, A. Solem, C. Christensen, L. Price November 1976, May 1980).

Lake Argyle: Sta. WA-246, 4 km north Lissadell Homestead (5 dead specimens, FMNH 200590, A. Solem, C. Christensen November 1976).

Kununurra: Sta. WA-240, Cave Springs, Cave Springs Range (2 dead specimens, A. Solem, C. Christensen 14 November 1976); Sta. WA-677, Sorby Hills (9 dead specimens, FMNH 205135, A. Solem, L. Price, F. and J. Aslin May 1980).

Ningbing Ranges, north of Kununurra: Northern section — Sta. WA-428, WA-429, WA-634, WA-641, WA-644, WA-649, WA-662, WA-663, WA-666, WA-668, WA-700, WA-702 (19 dead specimens, FMNH 199027, FMNH 199057, FMNH 204896, FMNH 204942, FMNH 204953, FMNH 204987, FMNH 205052, FMNH 205058, FMNH 205069, FMNH 205084, FMNH 205095, FMNH 205267, FMNH 205278); Central section — Sta. WA-230, WA-627, WA-628, WA-629, WA-650, WA-652, WA-657-9, WA-666 (44 dead specimens, FMNH 200575, FMNH 204867, FMNH 204869, FMNH 204876, FMNH 204996, FMNH 205001, FMNH 205024, FMNH 205030, FMNH 205034, FMNH 205039). All collected November 1976 and May 1980.

Jeremiah Hills, north of Kununurra: Sta. WA-435, WA-601, WA-673, WA-674 (6 live, 88 dead specimens, A. Solem, L. Price, F. and J. Aslin, May 1977 and May 1980).

Oscar Ranges: west side Brooking Gorge (5 dead specimens, WAM 364.81, D. Hembree 14 October 1975); Sta. WA-257, WA-258, Brooking Gorge (ca 30 dead specimens, FMNH 199490, FMNH 199549, A. Solem, L. Price, C. Christensen, November 1976); Sta. WA-255, Giekie Gorge Ranger Station (4 dead specimens, FMNH 199595); Sta. WA-259, 1.5km north-west Two Mile Bore (4 live specimens, FMNH 200346, A. Solem, L. Price, C. Christensen November 1976).

South-east Kimberley: Virgin Hills, 3 miles south-east Virgin Creek Bore, Gogo Station (1 dead specimen, WAM 371.81, G. W. Kendrick 18 July 1967); Gap Creek, Emanuel Range (48 dead specimens, WAM 136.68, G. W. Kendrick 9 August 1967); Cave Spring, Bugle Gap, Emanuel Range (22 specimens, WAM 368.81, A. M. Douglas and G. W. Kendrick 28 June 1966).

Near border of Western Australia and Northern Territory: Sta. WA-708, 43 km north

of Nicholson River (4 dead specimens, FMNH 205302); Sta. WA-245, WA-600, Duncan Highway, 11.6 km north of Behn River Crossing (ca 30 dead specimens, FMNH 199624, FMNH 204779, A. Solem, C. Christensen, L. Price, November 1976, May 1980); Rosewood Station turnoff, Old Duncan Highway (1 dead specimen, WAM 372.81, M. Archer 29 May 1970).

NORTHERN TERRITORY: Victoria Highway, Sta. WA-699, 18 km west of Desmond's Passage (2 dead specimens, FMNH 205257, May 1980).

Katherine area: Sta. WA-682, WA-683, WA-685-7, WA-689, WA-691-5 (ca 103 dead specimens, FMNH 205171, FMNH 205180, FMNH 205186, FMNH 205199, FMNH 205200, FMNH 205203, FMNH 205227, FMNH 205231-2, FMNH 205236, FMNH 205241, May 1980).

Red Centre: Sta. WA-113, Glen Helen, MacDonnell Range (many dead specimens, FMNH 182092, FMNH 201534); Sta. WA-133, Temple Bar Gap, MacDonnell Range (2 dead specimens, FMNH 182118); Sta. WA-131, WA-441, near Initiation Rock, Palm Valley (many specimens, FMNH 182077, FMNH 182112, FMNH 200654, FMNH 201551); Sta. WA-442, Cycad Gorge, Palm Valley (7 live specimens, FMNH 200484, 23 May 1977); Sta. 44, Palm Valley (4 live specimens, National Museum of Victoria, 23 May 1977); creek north-east Claraville (Alice Springs SF53-14 — 2780:0995) (3 dead specimens, FMNH 198921, F. and J. Aslin 24 June 1978); gorge north Old Huckitta Homestead Ruins, Dulcie Range (Huckitta SF53-11 — 3528:1888) (1 dead specimen, FMNH 198895); Florence Creek, Hale River (Alice Springs SF53-14 — 2741:1000) (1 dead specimen, FMNH 198947); Eurobra Gorge, north-east of Alice Springs (Huckitta SF53-11 — 3685:1706) (ca 56 live, 8 dead specimens, FMNH 198847, FMNH 198861).

SOUTH AUSTRALIA: Musgrave Ranges, south fringes. Sta. WA-886, 4.3km south of No. 8 Well, Mimili-Kenmore Park track (132° 32′ 56″ E, 26° 28′ 8″ S) (20 dead adults, Australian Museum, Sydney).

QUEENSLAND: Mapen, Batavia River (2 dead specimens, FMNH 132447).

Discussion: The above list of specimens covers only material studied for this revision, and omits much historical museum material examined many years ago. I have studied all types in the early 1960's, and confirmed the identity as *Stenopylis coarctata* (Moellendorff, 1894) of older material and specimens reported from Indonesia, Queensland and many more localities in the Red Centre.

There are some peculiarities of range that require comment. Although reported from Nightingale Island off the coast of Vietnam, no records exist for the south-east Asian mainland, Sumatra (van Benthem Jutting, 1959), Java (van Benthem Jutting, 1952: 406), Borneo, or the larger Philippine Islands. It has been taken from satellite islands off Java (van Benthem Jutting, 1952: 406), and them Sumba, Timor, New Guinea, and the Solomon Islands, but not from most intermediate areas. Quite possibly this reflects merely lack of careful collecting for minute land snails, since *Stenopylis coarctata* is easily overlooked because of its small size. But the lack of records from Luzon, Java, and Celebes, where extensive collecting has been carried out over the years, suggests that these gaps may be in part real.

In Australia, there is the unusual Port Hedland record in Western Australia. The specimens were taken in limestone rubble of a small raised reef that was mostly broken up to help build the airport roads. Undocumented records are from near Halls Creek. In November 1976, Carl C. Christensen and I spent five days visiting promising locations over a 50 mile radius. Two dead specimens of *Stenopylis* were the only land snails seen in this period — one was crushed by tweezers, the other fell into a deep boulder crevice and could not be retrieved. *Stenopylis* thus occurs as far south as Halls Creek, but the record is visual only. Otherwise, there are the scattered southern records in the wetter parts of the Napier, Oscar, and Emanuel Ranges. It is generally distributed across the northern part of the Kimberley, near Katherine, and well documented for

Queensland. According to John Stanisic (personal communication), the southermost record in Queensland is Nelly Bay, Cape Gloucester, north of MacKay.

The Northern Territory distribution is not continuous. Although common in the Katherine area, and present in the lower Victoria River drainage, *Stenopylis* is unknown from Darwin or Arnhem Land. So little sampling has been done in the latter region, that the situation is unknown. The region from Mataranka south to the Reynolds Range, north-west of Alice Springs, basically seems snail-free territory. The known range of *Stenopylis* in the Red Centre is from the Harts Range, north-east of Alice Springs, through the MacDonnell and Krichauff Ranges to Palm Valley and the Musgrave Range. Whether or not it will be found in the James or Petermann Ranges remains to be determined.

Thus both the extralimital and Australian ranges of *Stenopylis coarctata* contain large gaps that can be either the result of inadequate collecting, or actual absence of this genus.

Within the area of Australian distribution, *Stenopylis* has been recorded almost everywhere that *Westracystis lissus* (Smith, 1894) has been found (Solem, 1982: 179-182), although at fewer stations within each area. This undoubtedly reflects the much smaller size of the helicodiscid. In contrast, localities for *Discocharopa aperta* are few and scattered, suggesting that it is much rarer than *Stenopylis*.

Most live collections have been made under rocks in flood plain situations, although dead specimens are common in cave and talus accumulations. The large set from WA-218, Kalumburu Mission (FMNH 200542), came from an unusual situation in that they were living under a large boab tree situated on the edge of a banana patch that was routinely watered. At times the spray would reach the few limestone rocks at the base of the boab, thus giving a major increment to the water situation there. The snails with the largest animals still retained embryos, but most adults were retracted almost two whorls into the shell. They may well have shed young a short time prior to collecting.

Subadults develop a characteristic apertural armature of three barriers: 1) a long upper parietal ridge that is highest and most bulbous in the centre; 2) a lower parietal, egg-shaped blob; and 3) a mid-palatal blob situated opposite the bulbous section of the upper parietal. The first two blobs are retained in the adults inside the aperture (Haas, 1945: 11, fig. 1e), while the third one apparently is resorbed. They greatly narrow the shell aperture and would effectively prevent micro-arthropod entrance into the shell.

Family Charopidae

The Pacific Island taxa belonging to this family have been reviewed elsewhere (Solem, 1983), with extensive discussion of supra-generic categories. Remarks below are limited to those necessary to place the three northern Australian taxa into context of known units. They are very different from each other in almost every feature of their shell, and can be readily separated by the following key.

KEY TO THE CHAROPIDAE OF NORTHERN WESTERN AUSTRALIA

1. Apex depressed, microsculpture pitted (Figs 31-33). . . . . *Pilsbrycharopa tumidus* (Odhner, 1917)

   Apex slightly to moderately elevated, radial microsculpture 2

2. Diameter less than 2 mm, colour white, umbilicus widely open (Fig. 24) . . . . . *Discocharopa aperta* (Moellendorff, 1888)

   Diameter about 7 mm, colour yellow-brown, umbilicus rather narrow (Fig. 39) *Dupucharopa millestriata* (Smith, 1874)

Discocharopa aperta has one of the widest ranges known for any land snail, extending from the Philippines and Java to Borabora, Society Islands. The possiblity exists that this is a complex of species with mosaic distributions (Solem, 1983: 74-81), but much

anatomical study will be required before this question can be settled. The other two species are known from single collections.

Genus *Discocharopa* Iredale, 1913

Discocharopa Iredale, 1913, Proc. Malac. Soc. London, *10* (6): 379-380; Iredale, 1937, Australian Zool., *8* (4): 325; Iredale, 1937, South Australian Nat., *18* (2): 25; Solem, 1957, Fieldiana: Zoology, *42* (1): 2-6; Solem, 1959, Fieldiana: Zoology, *43* (1): 82-83; Solem, 1983, Endodontoid land snails from Pacific Islands, Part *II*: 74-81.

Type species. — *Charopa exquisita* Iredale, 1913.

Although Iredale (1937b: 325) referred several Tasmanian species to *Discocharopa,* and a Victorian species, *D. inexpectata* (Gabriel, 1947), is included by Smith and Kershaw (1979: 156), all of these taxa show major differences in shell micro-sculpture that make it improbable that they are correctly classified (Solem, unpublished). It is not possible to reclassify them at this time, but they are not considered to be true *Discocharopa* and are not discussed further.

Only one species is recognized, although it has been described at least six times. The two taxa based on Australian material, *concinna* Hedley, 1901 and *planorbulina* Tate, 1896, are identical in form and sculpture. The following synonymy is abbreviated from that presented in Solem (1983) to include only Australian literature.

Discocharopa aperta (Moellendorff, 1888)

Figs 9-10, 22-27

Patula aperta Moellendorff, 1888, Nachr.-Be. deut. Malak. Gesell., 20 (5-6): 89 — Montalban, Luzon, Philippine Islands.

Endodonta (Charopa) planorbulina Tate, 1896, Rep. Horn Exped. central Australia, Part II, Zool., 187, pl. 17, fig. 3 — Palm Creek, Krichauff Range, central Australia.

Endodonta concinna Hedley, 1901, Proc. Linn. Soc. N.S.W., *25*: 729, pl. 48, figs. 1-3 — Bundaberg, Queensland.

Discocharopa aperta (Moellendorff), Solem, 1983, Endodontoid land snails from Pacific Islands, Part *II*: 76-81, figs 35-37 — gives full extra-limital literature citations and discussion of variations.

Diagnosis: A minute species, diameter 1.3-1.6 mm in Australia, with 3 to 3 3/4 normally coiled whorls. Apex and spire slightly to moderately elevated (Fig. 23), last whorl descending gradually before aperture, height of shell 0.55-0.7 mm, H/D ratio 0.400-0.450. Apical sculpture (Fig. 25) of fine radial riblets, with spiral pressure folds visible at high magnification (Fig. 26). Postapical sculpture (Figs 9, 10, 27) of protractively sinuated radial ribs, narrow, crowded. Micro-sculpture usually eroded, absent from most of body whorl, very complex (Figs 9, 10, 27). Umbilicus broadly open, regularly decoiling, contained 2.30-2.90 times in the diameter. Colour faint yellow-white.

Holotype of *Endodonta (Charopa) planorbulina* Tate, 1896 — South Australian Museum D.3222, Palm Creek, Krichauff Range, central Australia.

Lectotype of *Endodonta concinna* Hedley, 1901 — Bundaberg, Queensland. Australian Museum C.8970.

Material studied: The following records are organized geographically, roughly west to east, and include only material examined for this study. Additional eastern Australian records are listed in Solem (1983: 78).

WESTERN AUSTRALIA North West Cape region: banks of Cy Creek, Cardabia Station (ca 97 dead specimens, WAM 400.72, G. W. Kendrick and T. A. Darragh 6 April 1969); Monajee Cave (= WAM Cave 6), Cape Range (31 dead specimens, WAM 71.992, WAM 71.1001, WAM 71.1007, WAM 71.1018 G. W. Kendrick and G. Hitchin 23 May 1965);

WAM Cave 1, Cape Range (7 dead specimens, WAM 65.485). Napier Range: Sta. NR V, north-west of Stumpy's Well (1 dead specimen, WAM 824.76, B. R. Wilson and S. Slack-Smith 29 August 1975); Sta. NRII 4a, ca 4.5 km north-west of Barker River crossing (Lennard SE51-8 — 247:829) (1 dead specimen, WAM 1757.78 B. R. Wilson and S. Slack-Smith 18 May 1976); Sta. WA-305, 0.5 km east of Yammera Gap (Lennard 3863 — 938:815) (1 dead specimen, FMNH 199245, L. Price and C. Christensen 10 December 1976); Sta. WA-303, 1 km east of Yammera Gap (1 dead specimen, FMNH 199179); flood debris at north end of The Tunnel (1 dead juvenile, WAM 1758.78, G. W. Kendrick 26 August 1967).

Oscar Ranges: Sta. WA-257, WA-258, Brooking Gorge entrance, north-west of Fitzroy Crossing (9 dead specimens, FMNH 199491, FMNH 199547); Sta. WA-255, near Giekie Gorge Ranger Station, Giekie Gorge National Park (3 dead specimens, FMNH 199597).

Ningbing Ranges, north of Kununurra: Sta. WA-620, WA-634, WA-649, WA-653, scattered localities (4 dead specimens, FMNH 204850, FMNH 204895, FMNH 204988, FMNH 205006).

NORTHERN TERRITORY MacDonnell Range: Sta. WA-113, Glen Helen opening to Finke Gorge (28 dead specimens, FMNH 182104, FMNH 201533); Sta. WA-133, Temple Bar Gap (1 dead specimen, FMNH 182119).

Krichauff Range, south-west of Alice Springs: Sta. WA-131, near Initiation Rock, Palm Valley (many dead specimens, FMNH 201550). Gill Range, south-west of Alice Springs: Sta. WA-446, Kathleen Spring (3 live specimens, FMNH 200476).

Discussion: The extralimital range of *Discocharopa aperta* is significantly greater than that of *Stenopylis coarctata,* in that the former ranges eastwards from the Solomon Islands to the Society Islands (Solem, 1983). The western limits of Java and the Philippines are quite comparable, except that *Discocharopa* has been collected on Java itself (van Benthem Jutting, 1952: 398), whereas *Stenopylis* is known only from satellite islands of Java (*Ibid.*, pp. 405-6). Neither genus has been recorded from Sumatra (van Benthem Jutting, 1959) or the south-east Asian mainland.

The known distribution of *Discocharopa aperta* in Australia is quite patchy. Its absence from the Prince Regent River, Mitchell Plateau, Drysdale River National Park, Kalumburu, and Katherine area is surprising, considering the abundance of *Stenopylis* and the intensity of collecting effort in these regions. Most records are based upon individuals found in dirt caked apertures of larger snails during sorting, and it seems likely that intensive collecting would expand the known range. My only collection of living individuals was made near Kathleen Spring in the Gill Range, Red Centre (Sta. WA-446), and these were taken from rocks.

The southern range limit of *Discocharopa* in Eastern Australia apparently lies in isolated temperate rain forest patches of north-eastern New South Wales, and both Lamington National Park and Bridge National Park in south-east Queensland (John Stanisic, personal communication).

In many parts of its range, *Discocharopa aperta* has a large, deeply recessed parietal barrier (Solem, 1983: 76, figs 35a-b), but this is not known for any Australian examples. Because of the fragmentary adult material available for this study, with many sets consisting of single broken examples, no study of local variation was attempted.

Genus *Pilsbrycharopa* Solem, 1958

Corinomala Iredale, 1939, Jour. Roy. Soc. Western Australia, *25*: 43 — type species *Endodonta (Charopa) tumida* Odhner, 1917. *Nomen nudum.*

Pilsbrycharopa Solem, 1958, Arch. Mollusk., *87* (1/3) 24; Solem, 1970, The Veliger, *12* (3): 240-254.

Diagnosis: Small to quite large Charopidae in which the apical sculpture of radial and spiral ridges may shift toward a pitted appearance (Figs 28, 31, 32). Whorls 3 1/2 to 4 1/2, highly variable in coiling pattern, shell shape variable. Postapical sculpture variable, usually prominent radial ribs present, microsculpture variable. Genital anatomy known only for one species, radula of another typically charopid.

Type species. — *Pilsbrycharopa papuana* Solem, 1958 (= *Charopa nigrofusca* Smith, 1896).

Comparative remarks

The previously known range of *Pilsbrycharopa* was Borneo to New Britain, Bismarck Archipelago. The genus itself was broadly defined (Solem, 1970) and recognized as potentially being artificial. Association of a northern Australian species with this complex is based upon the apical microsculpture (Figs 28, 31-33) of that species, which is transitional between that of *Pilsbrycharopa* and the New Guinea *Paryphantopsis* Thiele, 1928 (see Solem, 1959: plt. 13. fig. 6; Solem, 1970: 249, figs 1a, d). Revision of this complex will require much additional material. In the absence of new collections, little would be gained by fragmenting the complex into ill-defined genera. The apical sculpture is not duplicated in any Austro-Zealandic charopid known to me or Frank Climo (personal communication), and association of *P. tumidus* with the Indonesian-New Guinea species is the logical alternative. Iredale (1939: 43) listed a subgeneric name, *Corinomala,* but gave no description. It is considered to be a *nomen nudum.* If dissection shows that *P. tumidus* is separable on a generic or subgeneric level, then this name could be described and validated at that time.

***Pilsbrycharopa tumidus* (Odhner, 1917)**
Figs 28-36

Endodonta (Charopa) tumida Odhner, 1917, Kungl. svensk. Vetens. Handl., *52* (16): 72, figs 24-25, plt. 3, figs 72-74 — at the Pandanus spring, Noonkanbah, Fitzroy River, Western Australia.

Luinodiscus tumidus (Odhner), Iredale, 1937, Australian Zool., *8* (4): 331; Iredale, 1939, Jour. Roy. Soc. Western Australia, *25*: 42-43, plt. III, fig. 2.

Diagnosis: A medium sized species, diameter 3.61-4.04 mm (mean 3.83 mm), with 3 1/2 to 4+ (mean 3 2/3) normally coiled whorls. Apex and early spire sunken, body whorl barely descending before aperture (Fig. 29), height of shell 1.99-2.25 mm (mean 2.10 mm), H/D ratio 0.537-0.559 (mean 0.548). Apical sculpture (Figs 28, 31-33) complex, initially pitted (Fig. 32), becoming irregularly radially ribbed near end (Fig. 33). Postapical sculpture of 128-141 (mean 131.8) protractively sinuated radial ribs on the body whorl, whose interstices are two to four times their width (Fig. 34). Microsculpture (Figs 34-36) of fine radial riblets that have much finer spiral buttresses and small folded ridges. Each major rib with three micro-radials at its peak (Figs 35-36). Umbilicus (Fig. 30) relatively narrow, regularly decoiling, contained 3.96-4.19 times (mean 4.06) in the diameter. Colour light yellow horn.

Paratypes: Pandanus Spring, Noonkanbah Station, Fitzroy River, Kimberley, Western Australia (5 specimens, AM C.41900, Naturhistoriska Riksmuseet, Stockholm 942, E. Mjoberg 10 February 1911).

Discussion: The diagrams of radular cusps and jaw of *Pilsbrycharopa tumidus* (Odhner, 1917: 72, figs 24-25) show that these structures are consistent with classification in the Charopidae, but are not detailed enough to permit comments on generic placement.

Solem (1970: 264, Table 6) differentiated *Paryphantopsis* Thiele, 1928 and *Pilsbrycharopa* Solem, 1958 on trends in shape, sculpture, and size, and indicated that they might well be a complex of genera. The features of *Pilsbrycharopa tumidus* lend support to this possibility. In size, shape, sculpture, calcification, and micro-sculpture, it agrees well with that genus, but the apical micro-sculpture (Figs 31-33) comes closer to the pitted apex of *Paryphantopsis.* Depressed apices are a recurrent phenomenon in the Charopidae, and of little value in classification. Overall, *P. tumidus* does not

agree well with any of the five species clusters of *Pilsbrycharopa* outlined by Solem (1970: 241), showing features of different groups. No other Australian charopid comes close in matching its apical sculpture, while several of the Indonesian species approximate its features. Thus classification in *Pilsbrycharopa* is proposed pending availability of adequate materials for a modern revision of the entire complex.

Odhner (1917: 74) recorded several fresh-water molluscs from the Fitzroy River at Noonkanbah, but *Pilsbrycharopa tumidus* was the only land snail collected. Five of the eight known specimens have been examined. No more recent collections have been made at Noonkanbah Station to my knowledge.

Genus Dupucharopa Iredale, 1937

Australian Zool., *8* (4): 332; Iredale, 1939, Jour. Roy. Soc. Western Australia, *25:* 43-44.

Diagnosis: Shell relatively large, spire slightly elevated, umbilicus moderately open, only slight decoiling. Whorls about 4 3/4, normally coiled. Apical sculpture of rather widely spaced radial ribs crossed by fine spiral cords that become beaded on top of the radial ribs. Post-apical sculpture of low, rounded, rather widely spaced radial ribs crossed by fine spiral cords, with very fine radial micro-riblets between the major ribs. Anatomy unknown.

Type species. — *Helix millestriata* Smith, 1874.

Comparative remarks

The most unusual feature of *Dupucharopa* is that the spiral micro-sculpture is much stronger than the micro-radials (Fig. 45), with the latter, in effect, giving a beaded effect to the spirals at the point of crossing. This is very different from the situation found in any of the south-western Australian charopids (Solem, in preparation) or south-eastern taxa reviewed by Smith and Kershaw (1979). Both Smith (1974) and Iredale (1939) commented on the shell sculpture.

Some of the Indonesian *Pilsbrycharopa* (Solem, 1970) have sculpture that appear similar at optical magnifications, but more study is needed.

Until the anatomy can be studied, the unique microsculpture serves to distinguish *Dupucharopa millestriata* from any named Australian taxa, while its size, general appearance, and geographic location, suggest affinity with *Pilsbrycharopa.* There is insufficient evidence for synonymization of genera. Presentation of new illustrations and SEM photographs of the sculpture permit ready comparison with other taxa.

The original description of *Dupucharopa* (Iredale, 1937b: 332) was in error by saying the spire was depressed, since it clearly (Fig. 38) is elevated.

Dupucharopa millestriata (Smith, 1874)

Figs 37-45

Helix millestriata Smith, 1874, Zoology of the Voyage of H.M.S. *Erebus & Terror, II,* Mollusca, p. 2, plt. 4, figs 5 (top and bottom views) — Dupuch's (= Depuch) Island, West Australia.

Elaea millestriata (Smith), Tryon, 1885, Man. Conch., (2) *1*: 130, plt. 28, figs. 50-51.

Patula millestriata (Smith), Smith, 1894, Proc. Malac. Soc. London, *1*: 87.

Endodonta millestriata (Smith), Hedley, 1916, Jour. Roy. Soc. Western Australia, *1*: 220.

Dupucharopa millestriata (Smith), Iredale, 1937, Australian Zool., *8* (4): 332; Iredale, 1939, Jour. Roy. Soc. Western Aust., *25*: 43-44.

Diagnosis: Shell large, diameter about 6.75 mm, with 4 3/4 normally coiled whorls. Apex and spire slightly and evenly elevated (Fig. 38), body whorl descending gradually before aperture, height of shell 3.53 mm, H/D ratio 0.524. Apical sculpture (Figs 40-42) of rather widely spaced radial ribs, at least partly with calcareous sections (upper

left of Fig. 41), crossed by very fine and crowded spiral cords that become higher on top of radial ribs, giving a beaded effect (Fig. 42). Postapical sculpture of broadly rounded, low, rather widely spaced radial ribs (Figs 43-44), about 92 on remaining section of body whorl, whose interstices are about three to five times their width. Microsculpture of fine spiral cords continued from the apex (Figs 41, 43-45), plus extremely narrow and fine radial micro-riblets (Figs 44-45). A beaded effect occurs when the micro-spirals and micro-radials cross each other (Figs 44-45). Sutures deep, whorls strongly rounded above, somewhat flattened laterally above and below periphery. Umbilicus narrow, U-shaped, barely decoiling (Fig. 39), contained 4.48 times in the diameter. Lip broken for almost 3/16 of a whorl, obscuring apertural shape and inclination.

Lectotype of *Helix millestriata* Smith, 1874 — British Museum (Natural History) 44.12.27.17. Dupuch's (= Depuch) Island, West Australia.

Paratype — Dupuch's (= Depuch) Island, West Australia (1 specimen, British Museum [Natural History] 44.12.27.18).

Discussions: Only the type material is known, and all post-1890 references are based on the publications of E. A. Smith. The type locality, Depuch Island, is situated about 60 km east of Roebourne, along the Pilbara coast of Western Australia. To my knowledge, no biological collections have been made here since the voyage of the *Erebus* and the *Terror* in the early 1840's. *Rhagada richardsonii* (Smith, 1874) was collected at the same time, but no other land snails have been recorded from Depuch Island.

The most unusual shell sculpture of *Dupucharopa millestriata* (Figs 40-45) separates this species from any south-west Western Australia species of charopids (Solem, unpublished). Its size, shape, and sculpture seem much closer to that of the *Pilsbrycharopa* complex (see above), but until the species has been dissected, accurate classification is not possible. In view of its unusual sculpture and isolated geographic position, use of the name *Dupucharopa* is continued, although actual generic differentiation is uncertain.

DISCUSSION

Our level of knowledge concerning the four species reviewed above are very different. *Dupucharopa millestriata* (Smith, 1874) is known from two empty shells collected in the early 1840's on an island near Roebourne, Western Australia. SEM observations demonstrate that the shell microsculpture is quite different from that found in known southern Australia charopids, and can be compared with sculptural variations found in the *Pilsbrycharopa* complex of Indonesia to New Britain. A second Western Australia species, *Pilsbrycharopa tumidus* (Odhner, 1917), from Noonkanbah Station on the Fitzroy River, Kimberley, Western Australia, has the unique apical sculpture found in some New Guniea taxa, and thus is classified as an Indonesian taxon with more assurance. It is known from a single collection early in this century.

In contrast, both *Stenopylis coarctata* (Moellendorff, 1894) and *Discocharopa aperta* (Moellendorff, 1888) range from the Philippines through New Guinea and variously further into the Pacific. Dissection and SEM studies on both taxa provide good evidence as to thier affinities, and sufficient data has been recorded to enable comments concerning their patterns of distribution. *Stenopylis* is known from many more localities and seems to have a nearly continuous distribution. It is often collected in areas well removed from diversity centres for other land snails, in small pockets of trees or under scattered boulders in the shade of a large tree that are uninhabited by other snail species. *Discocharopa* is known from much fewer stations and has not been collected in many wetter areas of the Kimberley — Prince Regent River Nature Reserve, Mitchell Plateau, Kalumburu Mission, Drysdale River National Park — although these areas have been visited by highly competent snail collectors. Some of these absences are expected to be real.

No records of other charopids or punctids have turned up in the Kimberley or Pilbara, although both families are common in the Eastern States and along the south coast of Australia. Several small punctids are known from the Red Centre, but no other charopids besides *Discocharopa*. Punctids and charopids are common and diverse in the moister regions of south-western Australia, especially in the area from slightly north of Perth south to Cape Leeuwin and then east through the Stirling Ranges. Punctids continue east in the limestone refugia of the Nullabor, and these taxa are under study by Frank Climo, National Museum of New Zealand, Wellington, New Zealand.

Thus the few taxa reviewed and reillustrated here present a truely isolated grouping from the main Australian radiations of punctids and charopids. *Stenopylis* and *Discocharopa* are Indonesian species that have colonized Australia successfully. *Pilsbrycharopa tumidus* is interpreted as a dispersed taxon from Indonesia, quite possibly by migratory birds. The Fitzroy River near Noonkanbah has a narrow band of lushly vegetated islets and floodplain situations. They offer perhaps the best moisture conditions in the Kimberley for charopid land snails. At most times of the year this would be a natural stopping place for birds travelling to or from Indonesia and New Guinea. Evidence as to the affinities of *Dupucharopa millestriata* is too fragmentary for firm classification, but it is different in shell features from the main Australian charopid lineages, and thus is grouped here as a possible Indonesian straggler.

The previous two parts of this series, Solem (1981c, 1982) have dealt, respectively, with a limestone associated genus that has speciated in scattered hill systems (*Gyliotrachela* Tomlin, 1930), and a species whose habit of aestivating in curled up leaves in the litter (*Westracystis lissus* [E. A. Smith, 1894]) has given it a nearly universal distribution throughout the Kimberley. Both situations contrast with the distributions outlined above, and suggest that the small land snails of the Kimberley show independent distribution patterns.

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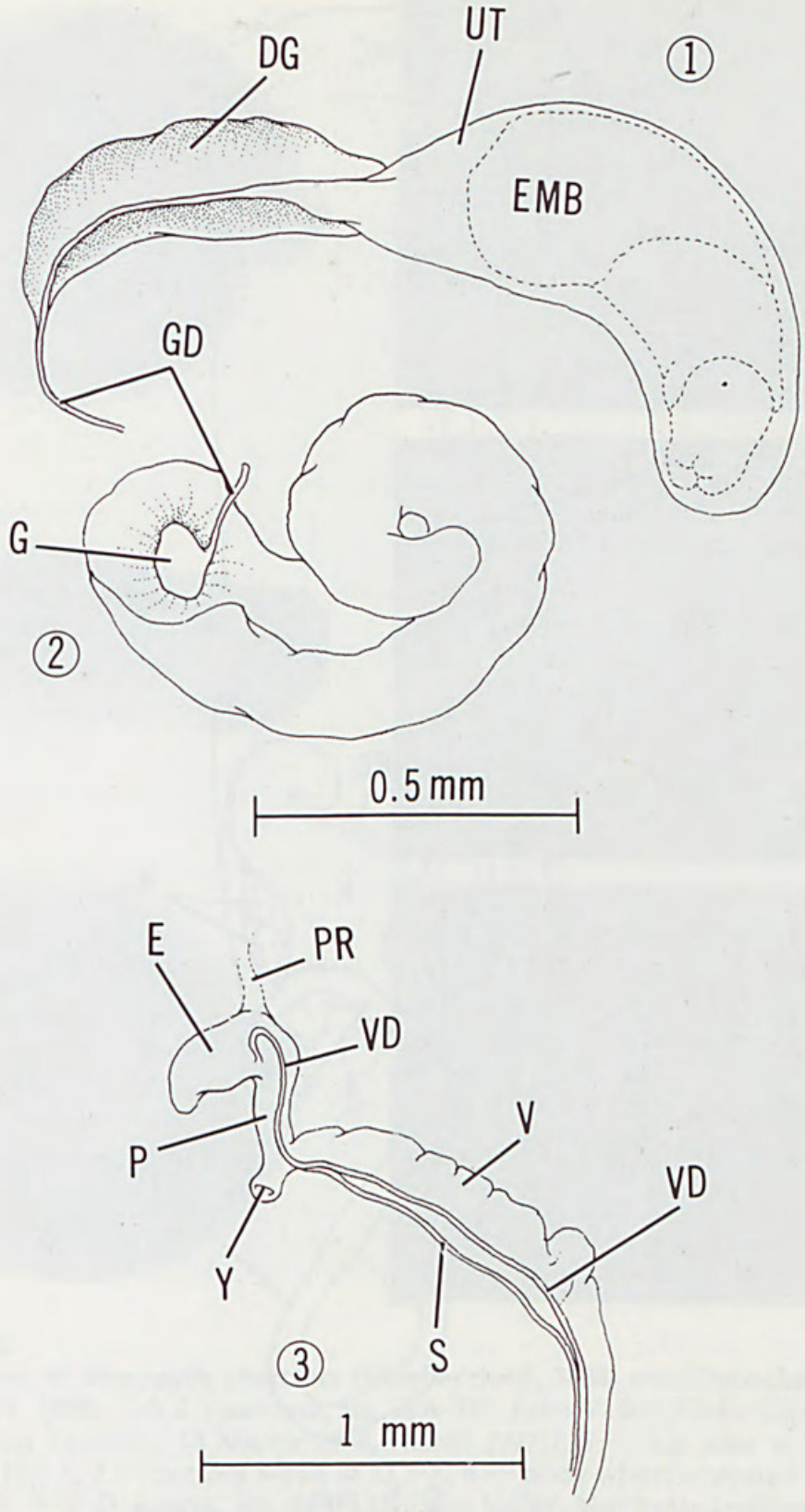
APPENDIX

List of anatomical abbreviations

A, anus; DG, prostate; E, epiphallus; EMB, embryo; G, ovotestis; GD, hermaphroditic duct; H, heart; HG, hindgut; HV, principal pulmonary vein; I, intestine; K, kidney; KD, ureter; KX, ureteric pore; P, penis; PR, penial retractor muscle; S, spermatheca; UT, uterus; V, vagina; VD, vas deferens; Y, atrium.



FIGURES 1-3
Genitalia of *Stenopylis coarctata* (Moellendorff, 1894): 1, 2 — Sta. WA-218, under large boab near Kalumburu Mission, Western Australia, 28 October 1976, FMNH 200538, 1 is pallial genitalia with an embryo (EMB) inside uterus (UT), 2 is apical genitalia, 3 — Sta. NR 5, north-west of Stumpy's Well, Napier Range, Western Australia, 29 August 1975, WAM 806.76, terminal genitalia. Scale lines as marked. Drawings by Elizabeth A. Liebman.

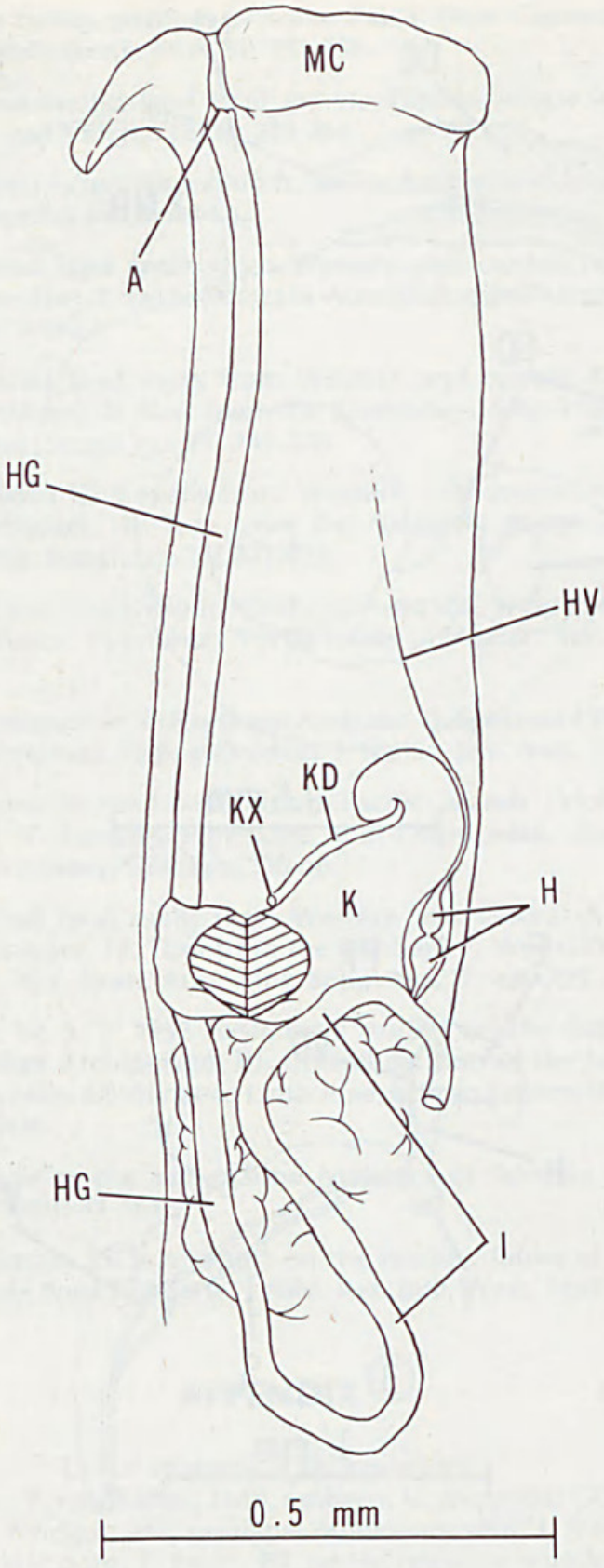
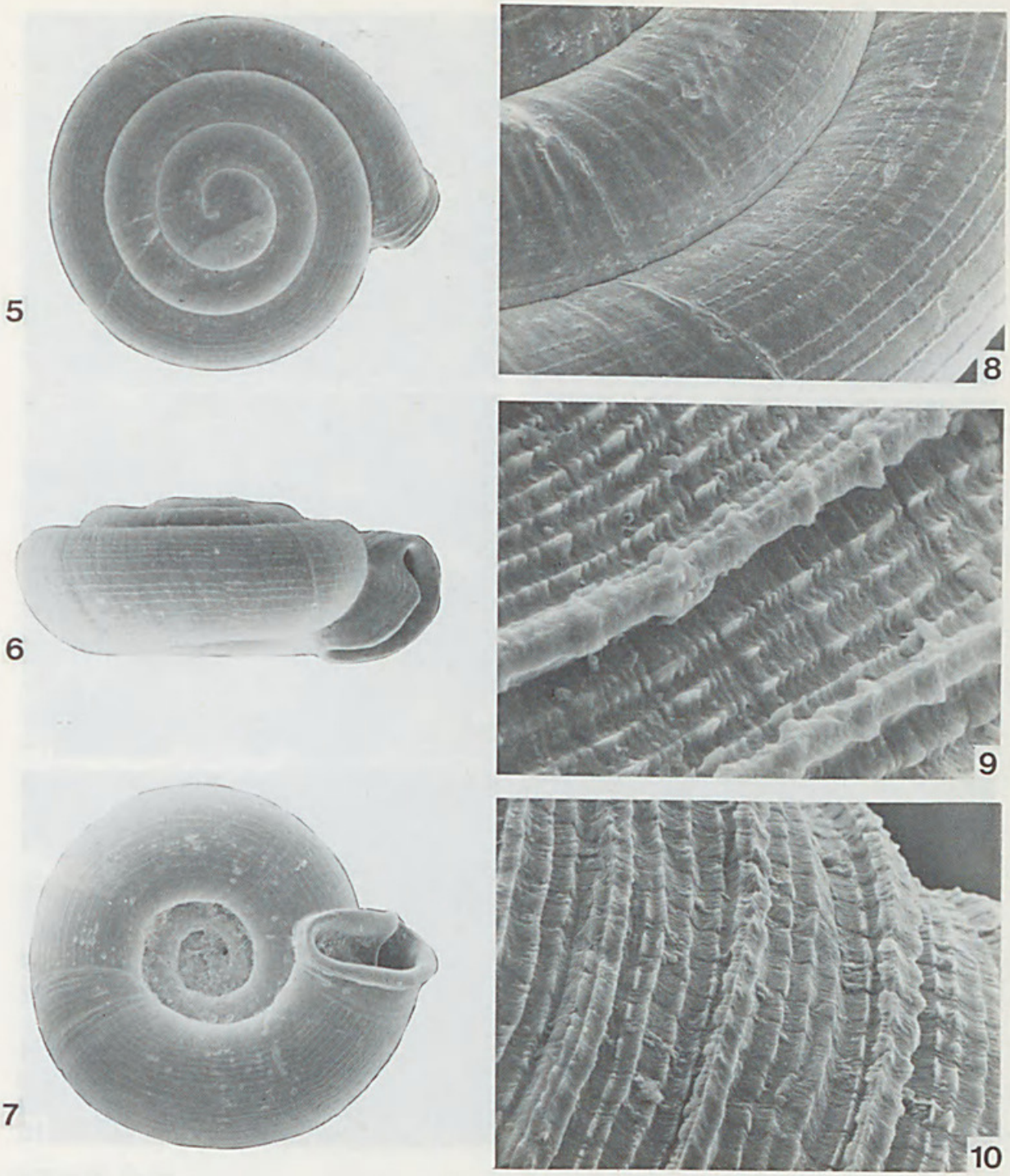
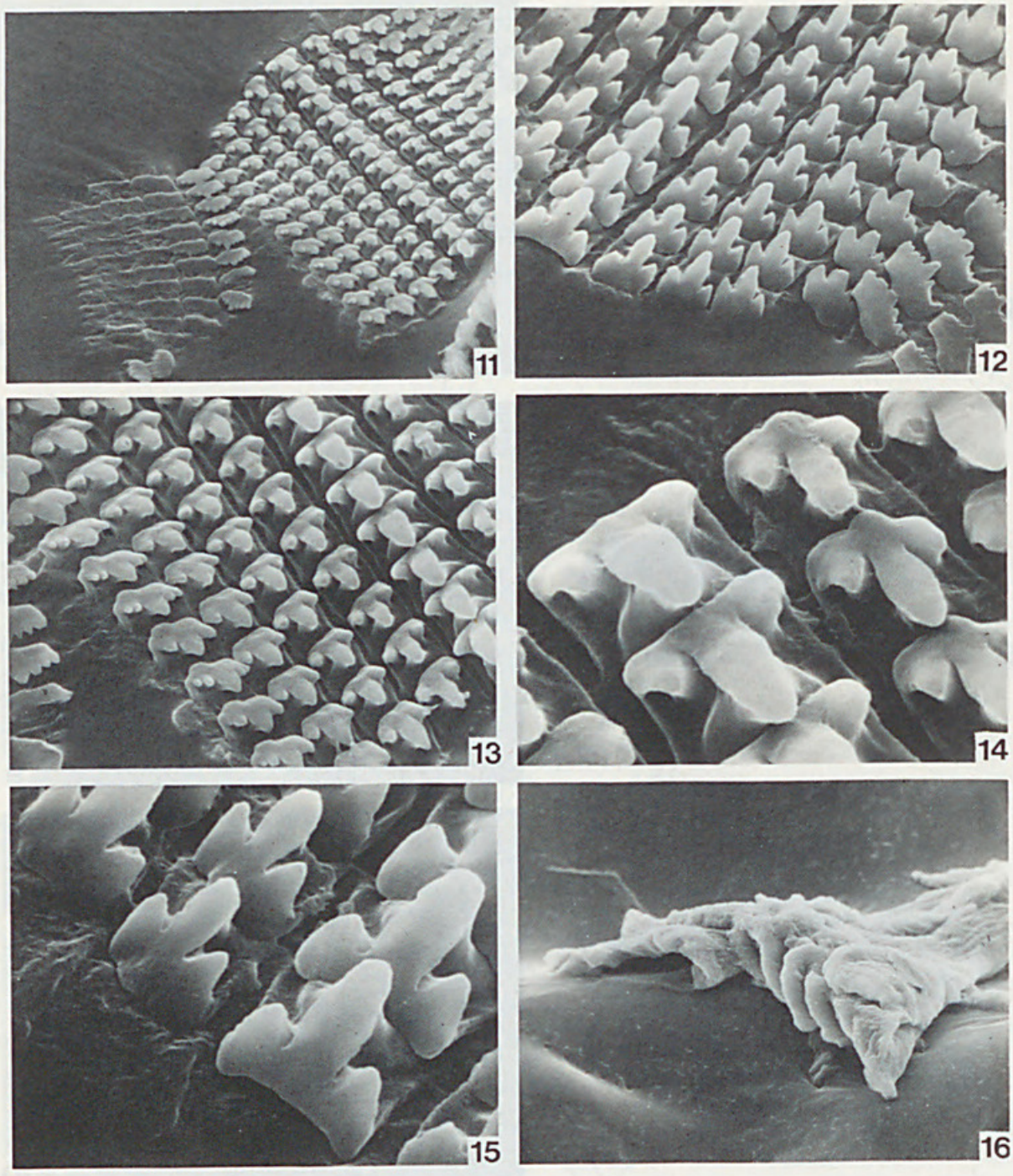


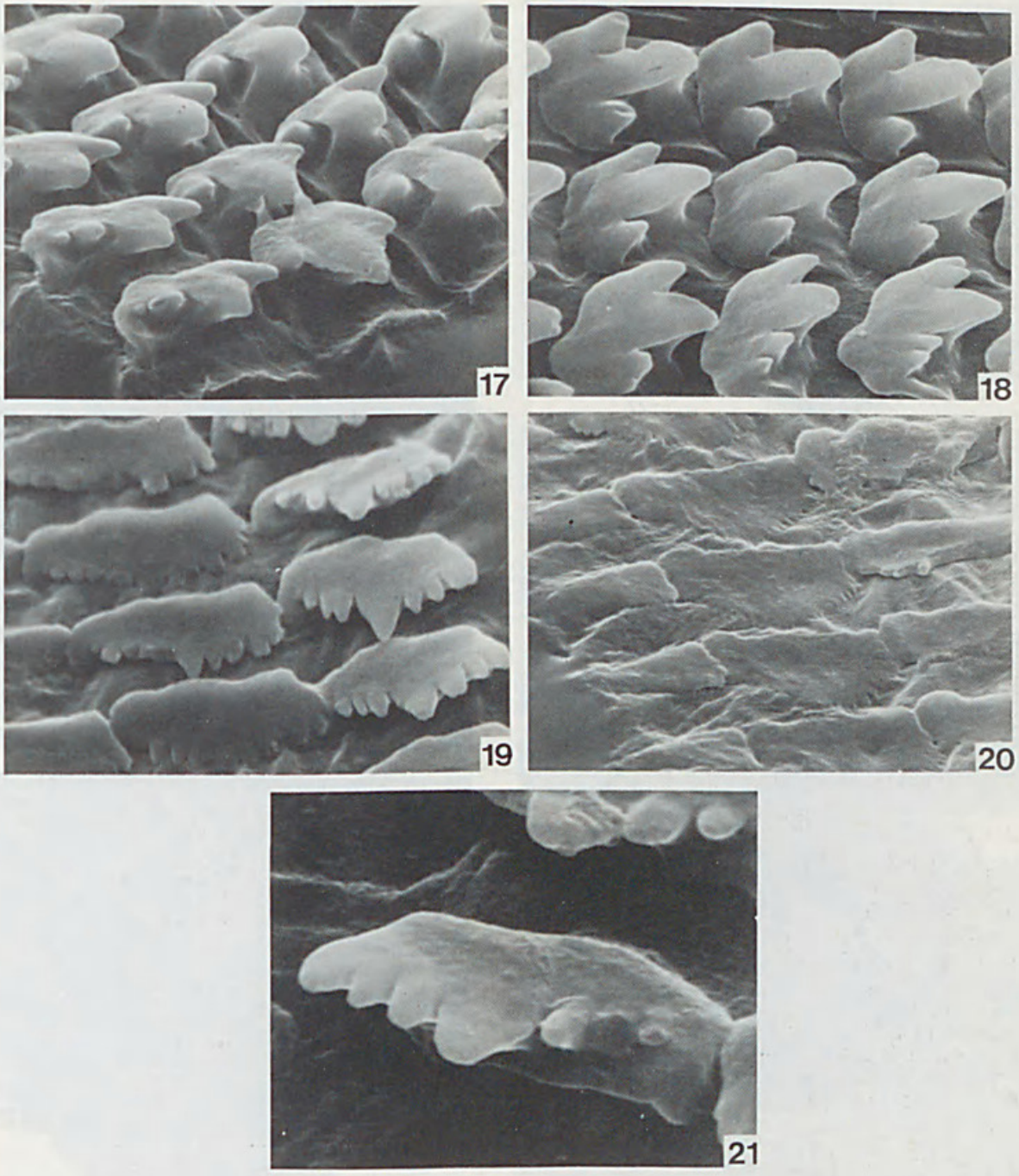
FIGURE 4
Pallial complex of *Stenopylis coarctata* (Moellendorff, 1894): Sta. WA-601, 13.7 km south of Limestone Mill, north of Kununurra, Western Australia, 16 May 1980, FMNH 204784. Scale line equals 0.5 mm. Drawing by Elizabeth A. Liebman.



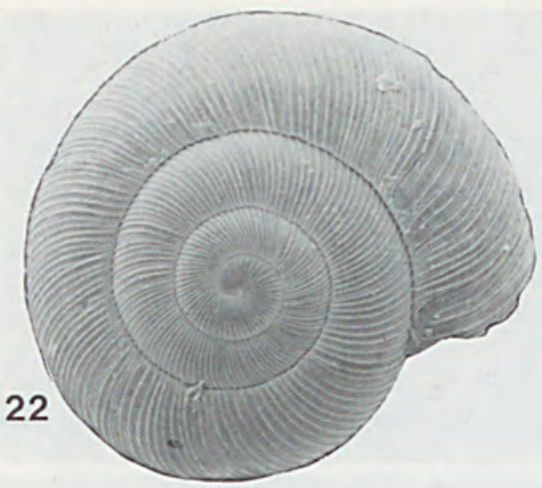
FIGURES 5-10
Shell sculpture of *Stenopylis coarctata* (Moellendorff, 1894) and *Discocharopa aperta* (Moellendorff, 1898): 5-8 *S. coarctata,* Sta, WA-131, Palm Valley, Finke Gorge National Park, Northern Territory, 18 March 1974, FMNH ??????, 5 — top view at 16.9 X, 6 — side view at 18.0 X, 7 — bottom views at 17.9 X, 8 — body whorl sculpture and growth pause at 70 X, 9-10 *D. aperta,* Sta. WA-131, Palm Valley, Northern Territory, 18 March 1974, FMNH 201551, 9 — microsculpture on penultimate whorl at 640X 10 — microsculpture on body whorl at 305X.

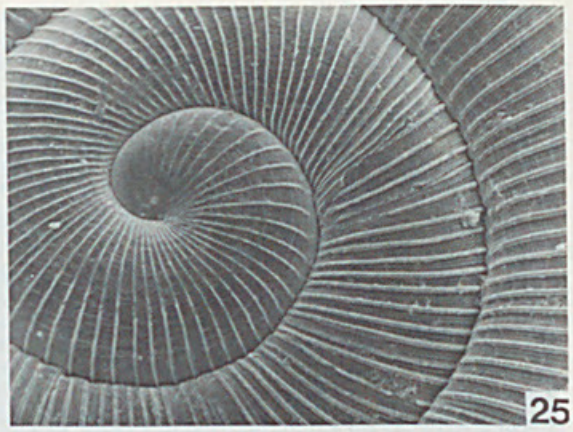


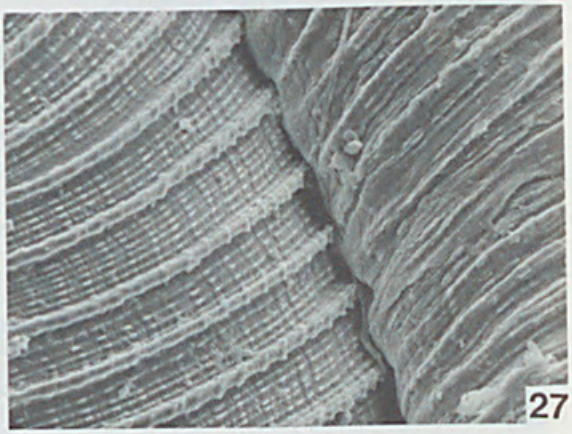
FIGURES 11-16
Radula and jaw structures of *Stenopylis coarctata* (Moellendorff, 1894): Sta. WA-601, 13.7 km south of Limestone Mill, north of Kununurra, Western Australia, 16 May 1980, FMNH 204784, 11 — part row of radular teeth at 310, 12 — central and lateral teeth viewed from high anterior angle, 610 X, 13 — lateromarginal transition at 530 X, 14 — central and lateral teeth viewed at high posterior angle at 1,575 X, 15 — central and early lateral teeth viewed at high anterior angle at 1,565 X, 16 — jaw edge and attachment membranes at 330 X.



FIGURES 17-21
Radular teeth of *Stenopylis coarctata* (Moellendorff, 1894): Sta. WA-601, 13.7 km south of Limestone Mill, north of Kununurra, Western Australia, 16 May 1980, FMNH 204784, 17 — lateromarginal transition at 1,670 X, 18 — late lateral teeth at 1,650 X, 19 — mid-marginal teeth at 1,690 X, 20 — outer marginal teeth at 1,645 X, 21 — mid-marginal tooth at 3,440 X.







FIGURES 22-27
Shell and microsculpture of *Discocharopa aperta* (Moellendorff, 1894): Sta. WA-131, Palm Valley, Finke Gorge National Park, Northern Territory, 18 March 1974, FMNH ??????, 22 — top view at 15.2 X, 23 — side view at 16.6 X, 24 — bottom view at 16.8 X, 25 — apical and post-apical sculpture at 59.2 X, 26 — micro-sculpture on early part of apex at 295 X, 27 — sculpture on penultimate and body whorls at 150 X.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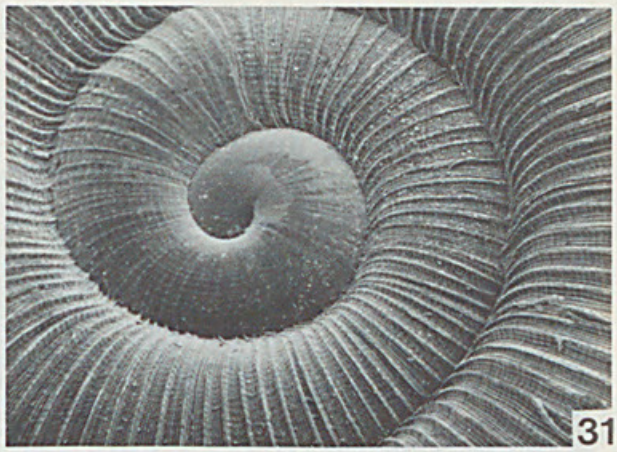
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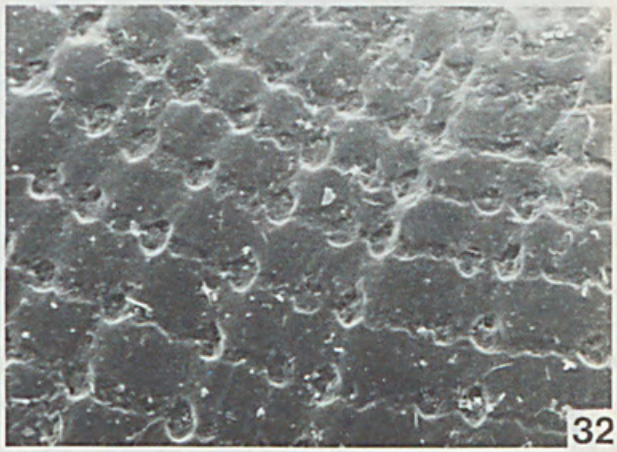
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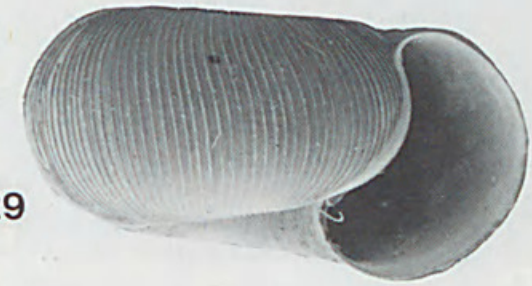
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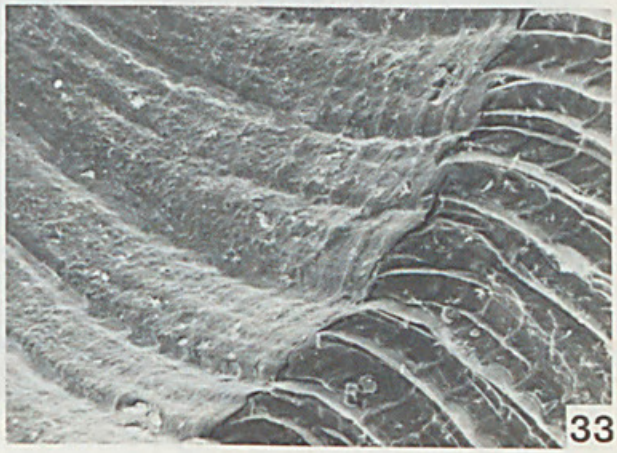
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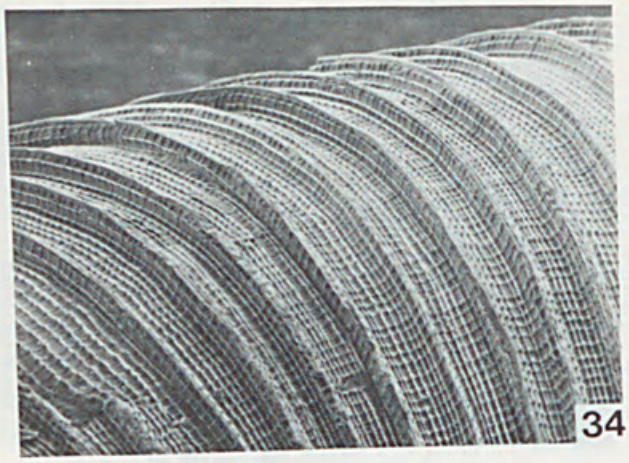
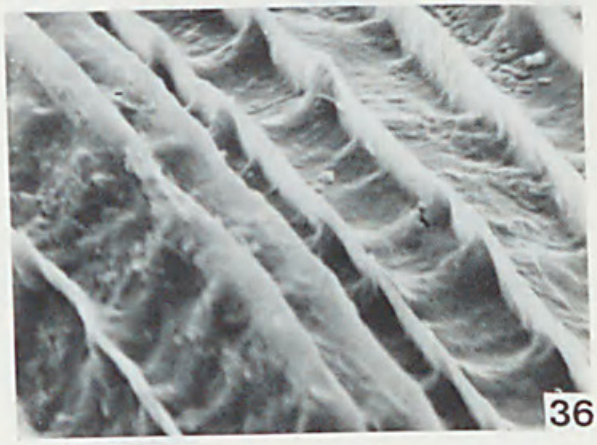
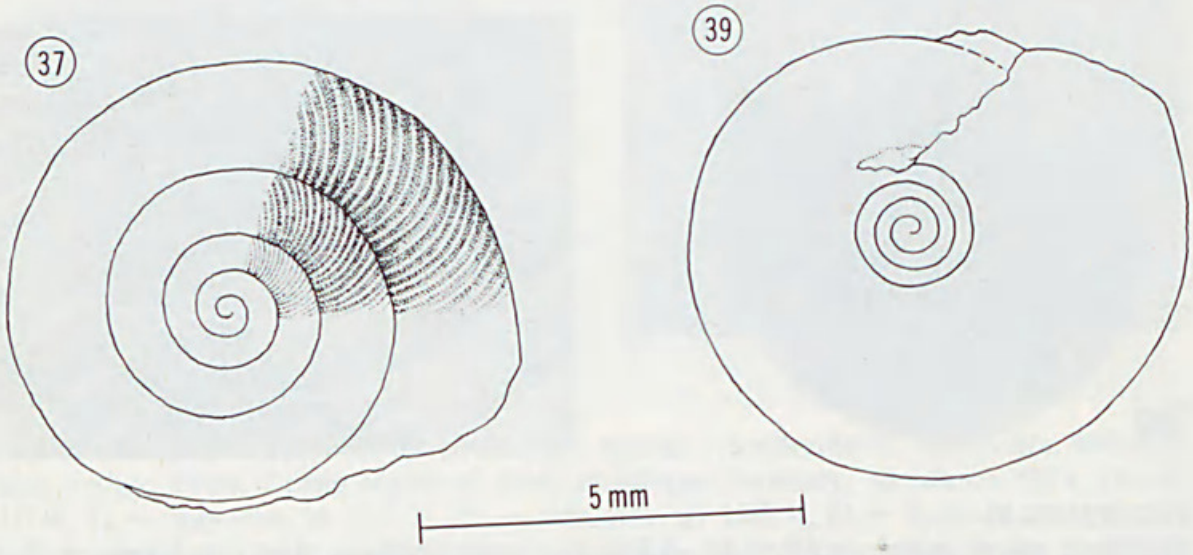
FIGURES 28-33
Shell and apical sculpture of *Pilsbrycharopa tumidus* (Odhner, 1917): Pandanus Spring, Noonkanbah, Fitzroy River, Western Australia, 10 October 1911, AM C.41900, 28 — top view at 7.7 X, 29 — side view at 8.9 X, 30 — bottom view at 7.2 X, 31 — apex and early spire at 37.2 X, 32 micro-sculpture on early apex at 380 X, 33 — micro-sculpture on late apex (left) and early spire (right) at 189 X.

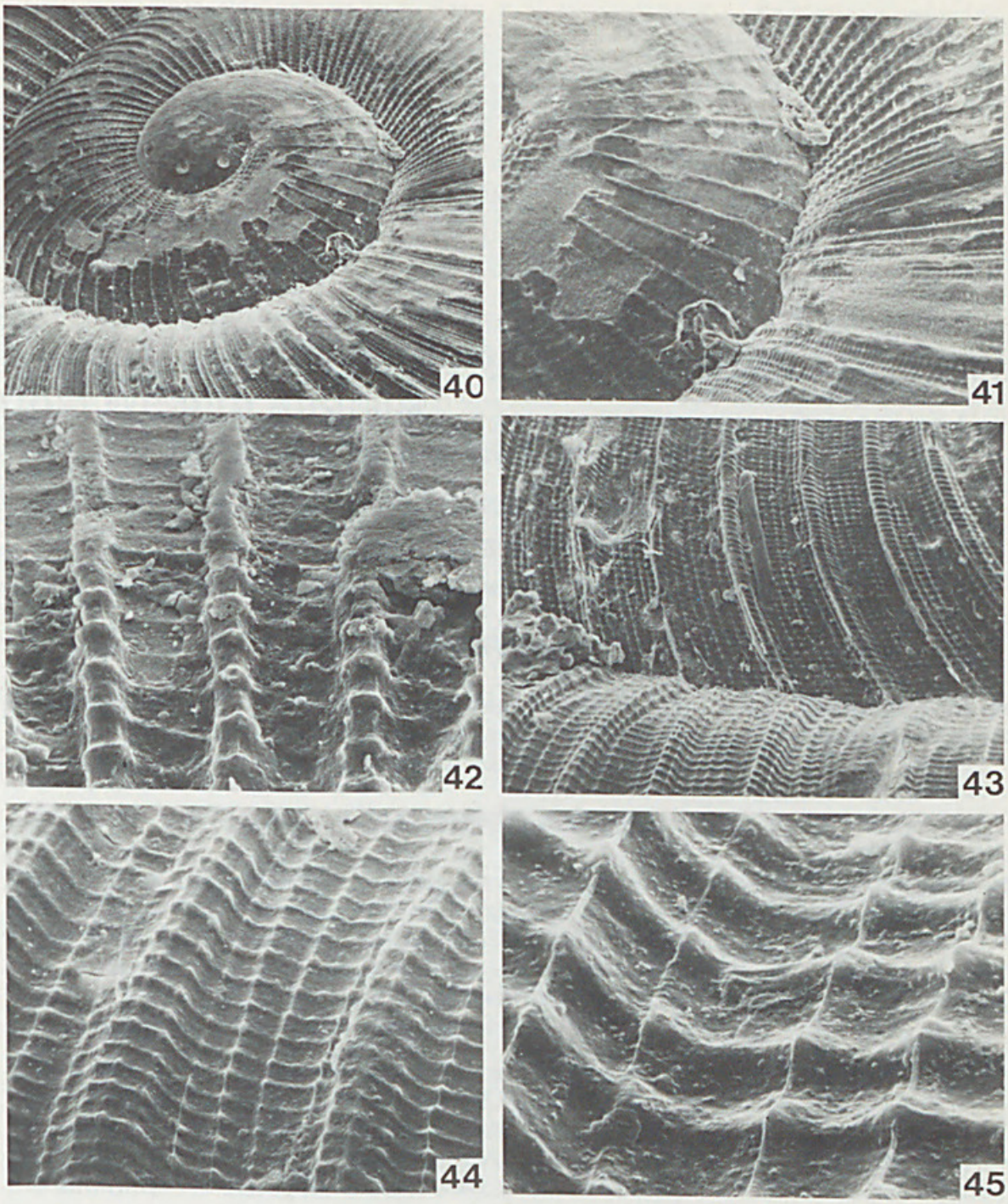




FIGURES 34-36
Postapical micro-sculpture of *Pilsbrycharopa tumidus (Odhner, 1917): 34* — portion of body whorl at 70 X, 35 — micro-sculpture between three major ribs at 350 X, 36 — top of major rib and micro-riblets at 1,045 X.



FIGURES 37-39
Shell of Dupucharopa millestriata (Smith, 1874): Depuch (= Dupuch's) Island, east of Roebourne, Western Australia. Holotype of *Helix millestriata* Smith, 1874, British Museum (Natural History) 1844.12.27.17. Scale line equals 5 mm. Drawings by Elizabeth A. Liebman.



FIGURES 40-45
Micro-sculpture of *Dupucharopa millestriata* (Smith, 1874): Depuch Island, east of Roebourne, Western Australia, British Museum (Natural History) 1844.12.27.17, holotype, 40 — apex and early spire at 42 X, 41 — detail of apex and early spire micro-sculpture at 84 X, 42 — detail of the apical micro-sculpture at 963 X, 43 — sculpture on 2nd and 3rd whorls at 81 X, 44 — micro-sculpture on 3rd whorl at 215 X, 45 — detail of 3rd whorl microriblets at 860 X.