

TABLE I—Comparative tabulation of some characteristics of species of *Anchura* and *A. (Helicaulax)*. Whorl profiles that are straight to slightly curved are listed as straight. The number under “angulate” indicates the placement of the angulation, and for *A. callosa* the position of maximum curvature: 2 = mid whorl, 3 = anterior third line of whorl, 4 = anterior quarter line. Pleural angles are averaged from those in Tables 2–11. Whorl diameter/height ratios are averaged from Dp/Hp ratios of Tables 2–11. *Anchura baptops* and *A.?* new species have axial ribs on less mature whorls only. The axial rib category “straight” includes slightly arcuate ribs. Cord count is from a spire whorl, posterior is the number of cords posterior to the angulation, maximum curvature, or strongest cord (=Cp of Tables 2–11); total is the suture number of cords (=Ct of Tables 2–11). Standard deviation ( $\pm$ ) of averages reflects post-depositional damages as well as variation.

Species of <i>Anchura</i> and <i>Anchura (Helicaulax)</i>	Number of speci- mens	Whorl profile			Whorl diam/ht ratio	Varices	Arcuate	Straight	Axial ribs	Number	Posterior	Spiral cords	Total
		Straight	Rounded	Angulate									
<i>A. baptops</i> new species	1	XXX	XXX	28°	1.9							1	3
<i>A.?</i> new species	1			18°	1.8							2	4
<i>A. gibbera</i> Webster	3	XXX	XXX	2	3.6	1.5 ± 0.02						3 ± 0.0	8 ± 0.6
<i>A. nanaimoensis</i> (Whiteaves)	3	XXX	XXX	2	1.5							1 ± 0.0	4 ± 0.0
<i>A. ainikta</i> new species	5	XXX	XXX	2	1.3	1.6 ± 0.26	XXX	XXX				14 ± 1.0	
<i>A. phaba</i> new species	10	XXX	XXX	3	3.4	1.7 ± 0.15						18 ± 2.3	
<i>A. falciformis</i> (Gabb)	8	XXX	XXX	3	2.6	1.7 ± 0.11						13 ± 1.5	
<i>A. halberdopsis</i> new species	7	XXX	XXX	2	2.8	2.0 ± 0.22	XXX	XXX				13 ± 1.8	
<i>A. callosa</i> Whiteaves	14	XXX	XXX	2	1.2	1.6 ± 0.77						13 ± 1.6	
<i>A. (H.) popenoei</i> new species	1	XXX	XXX	3	2.7	2.0	XXX	XXX				18 ± 1.6	
<i>A. (H.) tricosa</i> Saul and Popenoe	7	XXX	XXX	4	2.7	1.8 ± 0.14	XXX	XXX				2 ± 0.7	
<i>A. (H.) condoniana</i> (Anderson)	6	XXX	XXX	4	3.3	2.0 ± 0.22						15 ± 1.0	
												20 ± 0.9	
												4 ± 0.5	
												7 ± 0.8	

ment in Pacific Slope *Anchura*, *A. chapelvillensis* differs in having the juvenile whorls carinate rather than rounded, and the earliest adolescent whorls rounded rather than angulate, as seen in *A. callosa*, *A. falciformis*, *A. nanaimoensis*, and *A. gibbera*.

In the type species of *Anchura*, the shank is without posterior or anterior secondary spurs. Saul and Popenoe (1993) mistakenly suggested that typical *Anchura* be confined to species with no secondary spurs on the shank of the outer lip and having the anterior rostrum deflected to the left in apertural view. These features are, apparently only of specific importance, for Dockery (1993) has illustrated species of *Anchura* from the Campanian of Mississippi that have undeflected rostra and secondary spurs along the shank. Although the shanks of Pacific Slope Turonian species *Anchura (Helicaulax) condoniana* and *A. (H.) tricosa* Saul and Popenoe, 1993, have secondary spurs, none of the Pacific Slope Coniacian to Maastrichtian species discussed herein is known to have secondary spurs on its shank despite Gabb's (1864, 1868) original illustration of *A. falciformis* showing a secondary spur on the anterior edge of the shank. *Anchura abrupta* has the anterior rostrum deflected to the left in apertural view; the rostra of West Coast species *A. callosa*, *A. falciformis*, *A. phaba*, *A. ainikta*, *A. gibbera*, and *A. baptops* are not so deflected, but the rostrum of *A. falciformis* is bent slightly backward.

Some important characteristics used in differentiating Pacific Slope species of *Anchura* are tabulated in Table 1. Among the species included in this paper *Anchura halberdopsis* is most similar to *A. abrupta* in its sculpture. *Anchura callosa*, *A. falciformis*, *A. phaba*, and *A. gibbera* form a group, the *Anchura falciformis* group, having two strong cords anterior to the carina, spire sculpture of more or less arcuate, round-topped axial ribs crossed by narrower spiral cords, the axial ribs weakest posteriorly and strongest at the periphery, the anterior portion of the outer lip profile slightly scalloped, the aperture with a thick callus pad posterior to the basal sinus. *Anchura nanaimoensis* probably also belongs to this group. *Anchura ainikta*, *A. baptops*, and *A.?* new species are dissimilar. *Anchura (H.) popenoei* is most similar to *A. (H.) tricosa*, although its sculpture also is rather similar to that of *A. callosa*.

**Age.**—The total age range of *Anchura* is poorly understood and in need of reevaluation, as many forms previously assigned to the genus do not belong to it (see Sohl, 1960, p. 105). The genus appears to be constrained to the Late Cretaceous in the Gulf Coast region of North America (Sohl, 1960), but, on the Pacific Slope, undocumented species of *Anchura* apparently occur in the Early Cretaceous and *A. baptops* ranges into the Paleocene.

#### ANCHURA HALBERDOPSIS new species

Figure 3.1–3.4

**Diagnosis.**—A relatively small *Anchura* with strong, nearly straight costae on the spire and randomly occurring varices on the early whorls. Falcate outer lip strong and shaped like a halberd.

**Description.**—Shell medium-sized, high-spired, pleural angle about 30 degrees, drawn out anteriorly into anterior rostrum; whorl gently, unevenly rounded becoming slightly angulate on penultimate whorl and strongly angulate on last whorl; whorls about eight in number; suture appressed; protoconch unknown; varices randomly present on juvenile and adolescent whorls; growth line antipirally concave on spire. Mature sculpture strong, of both axial ribs and spiral cords; axial ribs nearly straight on spire, strongest on early whorls, weakening on body whorl, 11–13 on penultimate whorl, forming nodes where crossed by spiral cords, strong nodes developed on angulation of last whorl; spiral cords stronger on penultimate and ultimate whorls, four to five cords showing on spire whorls, fourth cord strongest, forming

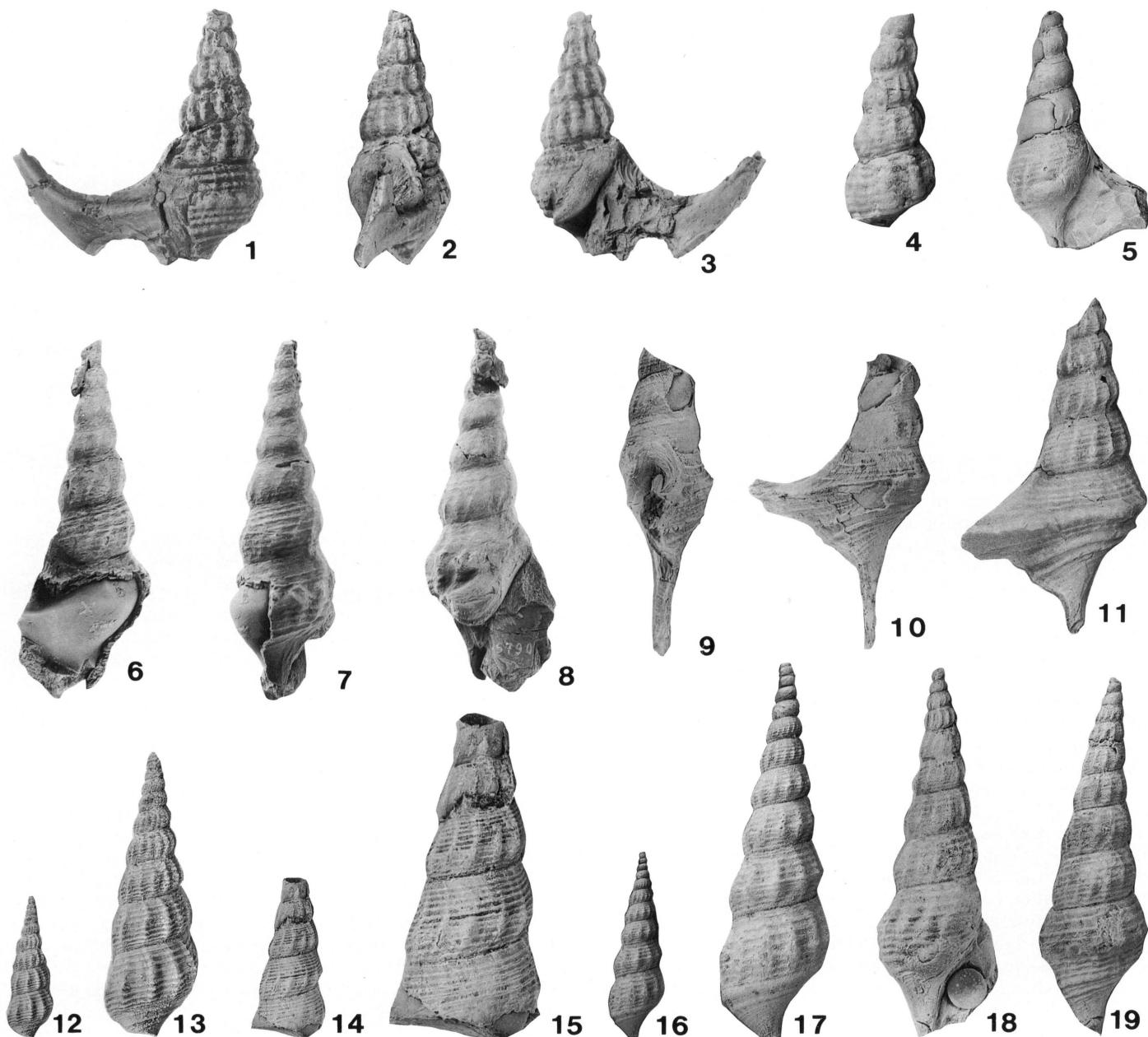


FIGURE 3—1–4, *Anchura halberdopsis* new species. 1–3, Holotype, abapertural, side, and apertural views,  $\times 1$ , LACMIP 11305, locality CIT 1053; 4, paratype, spire showing varices,  $\times 1.5$ , LACMIP 11311, locality CIT 1053. 5–19, *Anchura callosa* Whiteaves. 5, Hypotype, apertural view,  $\times 1$ , LACMIP 11315, locality UCLA 3637; 6–8, holotype, abapertural, side, and apertural views,  $\times 1$ , GSC 5790; 9, 10, hypotype, side and abapertural views,  $\times 1$ , LACMIP 11314, locality UCLA 3637; 11, hypotype, abapertural view,  $\times 1$ , LACMIP 11344, locality 3643; 12, 13, hypotype, abapertural view,  $\times 1$  and  $\times 2$ , LACMIP 11313, locality UCLA 3637; 14, 15, hypotype, abapertural view,  $\times 1$  and  $\times 2$ , LACMIP 11317, locality UCLA 3637; 16, 17, hypotype, abapertural view,  $\times 1$  and  $\times 2$ , LACMIP 11319, locality UCLA 3643; 18, 19, hypotype, apertural and abapertural views,  $\times 1$ , LACMIP 11312, locality UCLA 3635.

a noded keel on ultimate whorl and extending onto shank as carina; six to seven cords anterior of keel on ultimate whorl, third cord usually strongest; juvenile sculpture of closely spaced arcuate axial ribs on at least two whorls. Outer lip expanded into ax-shaped wing, anterior margin angulate (near 90 degrees) at posteriorward bend, thickened internally and filled with callus; posterior end of wing tilted near 15 degrees abaperturally to axis of spire. Aperture with moderately thick, broad inner lip extending apically almost to previous suture. Thick, sinuous, elongate callus pad formed on base along inner lip edge.

*Remarks.*—Although two dozen specimens are available, the rostrum is not preserved on any specimen, nor is the entire outer edge of the lip between the keel and the rostrum. The cords anterior to the keel on the ultimate whorl are of variable strength; commonly the third is strongest, but the third and fourth or the third, fourth, and fifth may be about equally strong and stronger than the other cords.

The thickened wing of this species with its angled anterior outline at the posteriorward bend is very different from those of *A. callosa* and *A. falciformis*, which are broader, less thick-

TABLE 2—Measurements in mm of *Anchura halberdopsis* new species. For abbreviations and symbols used, see introduction.

Specimen	H	Hp	Db	Dp	Dp/Hp	R	PA	S	Ct	Cp	A	Remarks
LACMIP 11305	38.2	7.0	17.0	13.8	1.97	—	26°	15.5	6	4	13	body + 5 whorls
LACMIP 11306	37.5	6.8	13.0†	12.8	1.88	—	27°	17.0	6	3	16	body + 6 whorls
LACMIP 11307	30.3	6.1	15.8	13.0	2.13	—	27°	—	5	2	13	body + 4 whorls
LACMIP 11308	37.0	6.2	—	12.6	2.03	—	22°	—	7	3	14	penult. + 6 whorls
LACMIP 11309	33.4	6.6	17.2	13.6	2.06	—	28°	—	6	2	13	body + 4 whorls
LACMIP 11310	29.8	6.5	17.5	13.5	2.08	—	27°	—	6	3	14	body + 3 whorls
LACMIP 11311	16.8	3.8	8.1	6.2	1.63	—	21°	—	7	—	10	juv. 5 whorls

ened, and have a more roundly expanded anterior margin at the posteriorward bend. The wing of *A. halberdopsis* is essentially similar to that of *A. abrupta* (see Sohl, 1960, plate 12, figures 1 and 4), but the former has a much shorter posterior arm, and the anterior arm is represented by little more than an abrupt angulation. The varices on the early whorls occur irregularly and are inconsistent in number; LACMIP 11311 consists of five whorls and has seven varices. The inner lip callus of *A. halberdopsis* is relatively thicker and extends higher on the apertural face than that of *A. callosa* or *A. falciformis*, reaching almost to the previous suture. The callus pad of *A. halberdopsis* is, however, less thick than that of *A. callosa*, *A. falciformis*, *A. phaba*, *A. gibbera*, or *A. baptos*. *Anchura halberdopsis* is stouter than *A. callosa*. None of the mature specimens of *A. halberdopsis* is as large as winged specimens of *A. falciformis* or *A. phaba*, and its sculpture is relatively rougher with a stronger axial component. *Anchura halberdopsis* has at least four cords, one of which is strongest, instead of the pair of strong basal cords characteristic of *A. callosa*, *A. falciformis*, *A. phaba*, and *A. gibbera*. The pattern of sculpture on *A. halberdopsis* more closely resembles that of *A. abrupta* than does the sculpture of *A. falciformis* or *A. phaba*. The sculpture of *A. halberdopsis* is still more similar to that of *A. (H.) condoniana*, differing mainly in the former having fewer axial ribs per whorl. *Anchura halberdopsis* also resembles *A. (H.) condoniana* in spire height, pleural angle, whorl profile, and in having a strongly noded keel on the ultimate whorl. *Anchura halberdopsis* differs in lacking the posterior digitation on the outer lip (but the posterior digitation is inconsistently developed in *A. (H.) condoniana*), in having varices on the early whorls, straighter axial ribs than those of *condoniana*, and in having a shorter shank to the wing, a more posteriorly directed posterior arm, and more of an anterior arm. As in *A. (H.) condoniana*, *A. (H.) tricosa*, and *A. abrupta* the anterior outer lip profile is evenly convex rather than scalloped as in species of the *A. falciformis* group.

*Anchura pacifica* Olsson, 1944, from the Maastrichtian "Baculites Zone" of Peru (Olsson, 1944) has similar distant, nearly straight axial ribs and cords on its spire, but on the body whorl *A. halberdopsis* has a more strongly noded periphery and fewer spiral cords on the base.

**Type specimens.**—Holotype LACMIP 11305, paratypes LACMIP 11306–11311 from CIT locality 1053

**Type locality.**—CIT locality 1053, northeast-southwest trending spur north of Santiago Creek, 200'N, 2850'E of SW corner sec. 20, T5N, R7W, El Toro quadrangle, Santa Ana Mountains, Orange County, California. Ladd Formation, upper part of Holz Shale Member.

**Measured specimens.**—See Table 2.

**Age.**—Early Campanian, *Turritella chicoensis holzana* Zone; associated with *Submortoniceras chicoense* (Trask) at UCLA locality 4192.

**Geographic distribution.**—Santa Ana Mountains, Orange County, California in the upper part of the Holz Shale Member

of the Ladd Formation [CIT 1053, (20 specimens); UCLA 4192 (2 specimens)], where it is locally common.

**Etymology.**—English, halberd, a shafted weapon with an ax-like cutting blade + Greek, *opsis*, having the aspect of.

#### ANCHURA CALLOSA Whiteaves, 1903

Figure 3.5–3.19

*Anchura stenoptera* Goldfuss. Whiteaves, 1879, p. 123, pl. 15, figs. 11–11a. Not *Rostellaria stenoptera* Goldfuss, 1844.

*Anchura callosa* Whiteaves, 1903, p. 358 (nom. nov. for *A. stenoptera* Goldfuss of Whiteaves).

*Anchura falciformis* (Gabb). Taff, Hanna, and Cross, 1940, p. 1327, pl. 2, figs. 7–9. Not *Anchura falciformis* (Gabb, 1864).

**Diagnosis.**—An Anchura with 12–14 slightly curved axial ribs per whorl; whorl profile rounded on spire with greatest curvature slightly below mid point, angulate on body whorl.

**Description.**—Shell large, high-spired, drawn out anteriorly into a moderately long anterior rostrum; pleural angle about 22 degrees; whorls about ten in number, nearly evenly convex with greatest curvature slightly below mid whorl; last whorl strongly carinate; suture appressed; growth line antipirally concave on spire; protoconch possibly of about three whorls, not obviously set off from teleoconch. Juvenile sculpture of fine, curved axial ribs; mature sculpture of both axial ribs and spiral cords; axial ribs slightly curved concavely to the aperture, distant, 12–14 on penultimate whorl, slightly nodose where crossed by cords, nodes strongest on angulation of ultimate whorl; eight to ten cords on spire, slight angulation on fifth or sixth cord, forming noded keel on ultimate whorl, base of whorl with two strong cords and four to five weaker cords. Outer lip expanded into falcate wing with shank of moderate length and longer posterior arm; keel of body whorl extends onto wing near posterior margin of wing; wing somewhat expanded with anterior edge rounded at posteriorward bend, thickened along posterior margin, interior channeled opposite keel; distal margin bent adaperturally; posterior arm inclined adaperturally at angle of about 10 degrees to coiling axis. Aperture with broad posterior sulcus and broad anterior sulcus delineated posteriorly by parietal callus pad. Inner lip forming a broad, thin wash to whorl angulation and onto whorl face, developing an elongate, thick callus pad at two strong subperipheral spiral cords. Callus wash continuing around base and onto base of rostrum.

**Remarks.**—Chico Creek specimens of *Anchura* occurring between about 549 m and 915 m above the base of the Chico Formation constitute a species differing from *A. falciformis* in having a narrower pleural angle, a more rounded profile to the spire whorls, weaker spiral ornament, usually lower axial ribs, sculpture on the abapertural side of the body whorl that is not effaced, producing a more angulate body whorl. Specimens are most distinct from *A. falciformis* low in the Tenmile Member of the Chico Formation but become more similar upsection. Specimens are abundant at UCLA locality 3637 (approx. 625 m above the base) but are difficult to extract from the matrix,