PALEOBIOS

Contributions from the University of California
Museum of Paleontology, Berkeley

No. 17 July 25, 1974

HEPTRANCHIAS HOWELLII (REED, 1946) (SELACHII: HEXANCHIDAE) IN THE EOCENE OF THE UNITED STATES AND BRITISH COLUMBIA

by

Bruce J. Welton

HEPTRANCHIAS HOWELLII (REED, 1946) (SELACHII: HEXANCHIDAE) IN THE EOCENE OF THE UNITED STATES AND BRITISH COLUMBIA

BY BRUCE J. WELTON[1]

ABSTRACT

Notidanion howellii Reed, 1946 (Selachii: Hexanchidae) from the Eocene Shark River Formation of New Jersey is referred to the genus Heptranchias. Teeth of Heptranchias from the Eocene of Vancouver Island, British Columbia, the Lincoln Creek Formation of Washington, and the Keasey and Nestucca Formations of Oregon are considered to be conspecific with Heptranchias howellii. H. howellii is chronologically restricted to strata of Narizian and lower Refugian age in the northeastern Pacific and is interpreted to be a deep water form, occurring in association with upper bathyal-lower neritic invertebrate faunas.

INTRODUCTION

Gill (1885) defined the family Hexanchidae to include three extant genera, Hexanchus Rafinesque, 1810, Notorhynchus Ayres, 1855, and Heptranchias Rafinesque, 1810. Hexanchus and Notorhynchus had a cosmopolitan distribution throughout the Cenozoic whereas Heptranchias is presently known only from the Oligocene of Japan (Applegate and Uyeno, 1968) and the Eocene of Vancouver Island, British Columbia (Waldman, 1971).

Reed (1946) described Notidanion howellii, a new Eocene shark of the family Notidanidae from the Shark River Formation of New Jersey. She stated that "In size, Notidanion howellii compares favorably with the Cretaceous and Early Tertiary species of Notidanion microdon (Agassiz), Notidanion serratissimus (Agassiz), and Notidanion tenuidens (Leriche), all of which were originally described as species of Notidanus. It differs from Notidanion microdon (Agassiz) and Notidanion serratissimus (Agassiz) in having the anterior denticles much larger, and in having a different number and arrangement of accessory cones. It differs from Notidanion tenuidens (Leriche) in the greater thickness of the root, more numerous anterior denticles and fewer accessory cones" (Reed, 1946: 3).

There is a great similarity between Reed's figures of N. howellii and teeth of Heptranchias which Waldman (1971) figures from the Eocene of Vancouver Island, British Columbia. Waldman did not compare his specimens with N. howellii; however, subsequent

[1]Museum of Paleontology, University of California, Berkeley, 94720.

examination of his specimens revealed that these two forms are congeneric and probably conspecific.

Welton (1972, 1973) described Heptranchias from the late Eocene of Oregon but refrained from making a specific diagnosis. Morphologically the Oregon teeth differ only slightly from N. howellii and I now consider them to be conspecific.

Heptranchias and Hexanchus were defined by Rafinesque in 1810 for sharks having seven and six pairs of gill openings, respectively. Cuvier (1817, 1829) placed both genera in synonomy with Notidanus Cuvier, 1817 (= Notidanion Reed, 1946) in the family Notidanidae. The name Hexanchus has priority over Notidanus, a problem discussed by Applegate (1965b). He demonstrated that each of these genera may be distinguished from the others on the basis of tooth morphology, the lower laterals in particular. Hexanchus may have either a smooth (as in the case of juvenile teeth) or serrated symphysial margin on the primary cusp (Fig. 1E). Heptranchias has one to five distinct narrow denticles on the symphysial margin of the primary cusp (Fig. 1C), and the third genus of Hexanchidae, Notorhynchus, differs in having small unequal denticles (Fig. 1D).

The lower lateral teeth in Hexanchus and Notorhynchus exhibit a large primary cusp and smaller secondary cusps which decrease in height along a gradient from sc_1, sc_2, sc_3 ... to the last cusp (Fig. 1 D, E). Heptranchias (Fig. 1 A-C and Pl. 1) resembles other hexanchids in having a large primary cusp and differs in its ungraduated secondary cusp pattern.

The meagerness of the fossil record of Heptranchias is more apparent than real and is due in part to systematic and taxonomic confusion regarding generic differences in the Family Hexanchidae. For example, in a paper describing the elasmobranch faunas of Australia, Pledge (1967: 140) stated that "Notidanus Cuvier included Hexanchus and Heptranchias Rafinesque 1810, and Notorhynchus Ayres 1855, as there is no apparent generic difference between the teeth of these living genera." Of the four figured hexanchid teeth (Pledge, 1967: pl. 1, figs. 1-3) which he refers to Notidanus serratissimus Agassiz, the lower tooth in fig. 3 belongs to Heptranchias and the remainder are clearly lower laterals of Hexanchus.

Jordan (1907) described Heptranchias andersoni on the basis of four teeth from Barker's Ranch (Hemingfordian), Kern County, California. Leriche (1908) synonymized Heptranchias andersoni with Notidanion primigenius and Arambourg (1927) referred Heptranchias andersoni to Hexanchus gigas. I consider Arambourg's generic assignment to be correct but hesitate to refer the West Coast species to a European taxon (Hexanchus gigas) until the former has been adequately diagnosed.

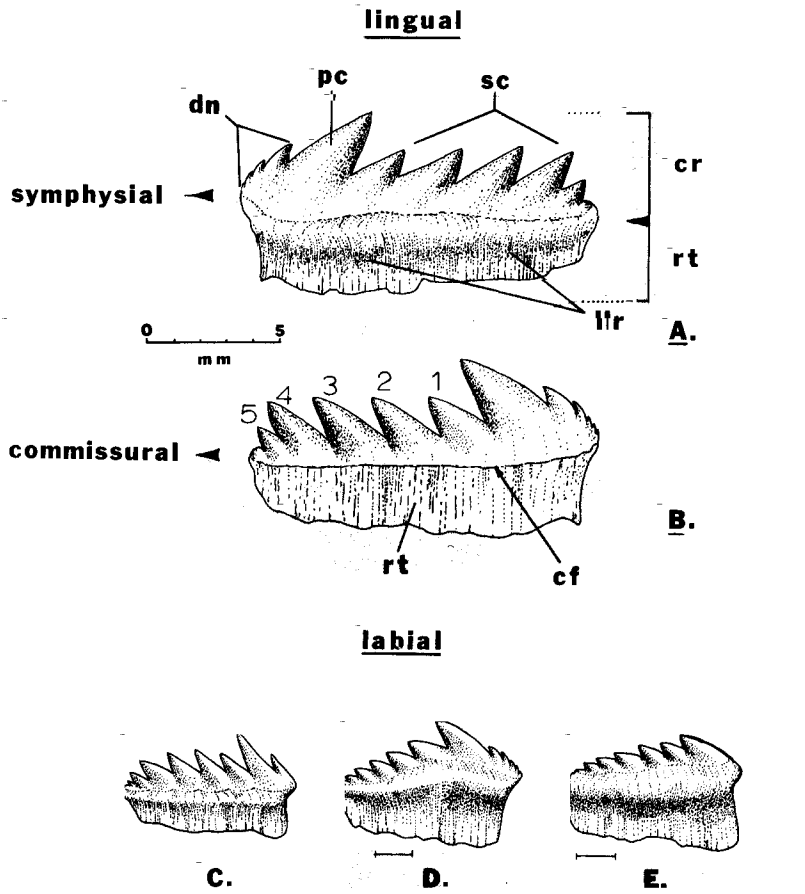
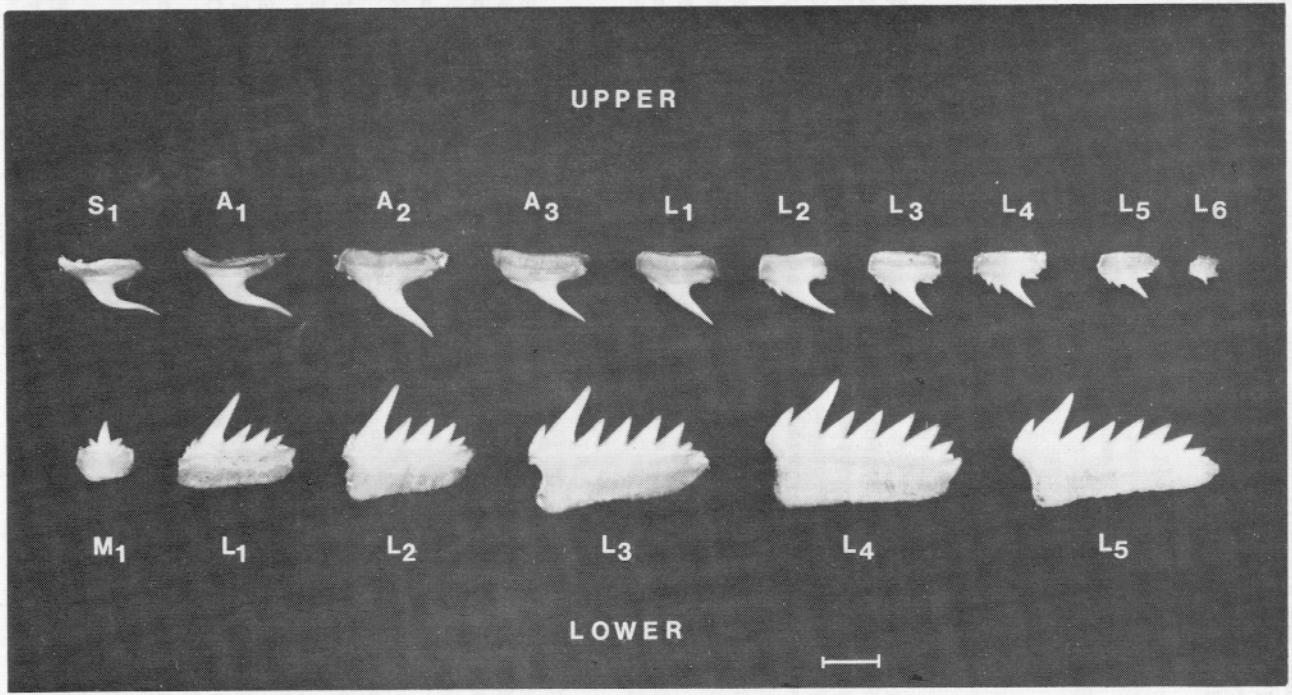


Figure 1. A & B, Heptranchias howellii (Reed, 1946); holotype, ANSP 15078, lower left lateral tooth. C. Heptranchias perlo; LACM F-468, lower left fourth lateral tooth, scale line = 2 mm. D. Notorhynchus maculatus; LACM F-461, lower left fourth lateral tooth, scale line = 4 mm. E. Hexanchus griseus; LACM F-107, lower left fourth lateral tooth, scale line = 4 mm. Abbreviations: cf, crown foot; cr, crown; dn, denticles; llr, longitudinal lingual ridge; pc, primary cusp; rt, root; sc, secondary cusps, numbered one through five.

PLATE 1. Heptranchias perlo, LACM F-468, collected in Suruga Bay, Shizuoka, Japan; upper and lower left tooth series: lacking L^7 in the upper series and posteriors in both upper and lower series. Abbreviations: A, anterior; L, lateral; M, medial; S, symphysial; scale line = 5 mm.


UPPER
S1
A1
A2
A3
L1
L2
L3
L4
L5
L6
M1
L1
L2
L3
L4
L5
LOWER

It is the purpose of this paper to reconsider the species Notidanion howellii Reed, 1946 and to discuss its chronologic, biogeographic and paleoecologic occurrence in the Eocene of western Oregon, Washington, and Vancouver Island, British Columbia.

ABBREVIATIONS

The following abbreviations are used: ANSP, Academy of Natural Sciences of Philadelphia; GSC, Geological Society of Canada, Ottawa; LACM, Natural History Museum of Los Angeles County, Vertebrate Paleontology Section; NSMT, National Science Museum, Tokyo, Japan; PSU, Portland State University, Earth Sciences Museum, Portland, Oregon; UCMP, University of California Museum of Paleontology, Berkeley; UW, Burke Memorial Washington State Museum, Division of Geology and Paleontology, University of Washington, Seattle; CR-7, UW-CR-6, locality numbers used in unpublished text of John M. Armentrout's (1973) University of Washington Ph.D. dissertation.

The tooth terminology used in this paper is based in part upon Applegate (1965a) and Compagno (1970), and is illustrated in Fig. 1 A and B.

ACKNOWLEDGEMENTS

I am grateful for criticisms and advice offered by Dr. J. T. Gregory and Mr. J. H. Hutchison of the Department of Paleontology, University of California, Berkeley. Dr. Shelton P. Applegate, Associate Curator of Vertebrate Paleontology of the Natural History Museum of Los Angeles County, offered encouragement and advice as well as access to the paleontological collection. Dr. John M. Armentrout, now of Mobil Oil Corporation, Denver, Colorado kindly supplied locality and stratigraphic data for the Washington specimen of Heptranchias. Mr. Armando Solis of the Natural History Museum of Los Angeles County photographed the tooth set of Heptranchias perlo (Plate 1).

SYSTEMATICS

Order HEXANCHIFORMES Berg, 1940

Family HEXANCHIDAE Gill, 1885

Genus Heptranchias Rafinesque, 1810

(Figure 1A, B, C; Plates 1, 2)

Diagnosis: Teeth different in upper and lower jaw, with upper anteriors bearing a single commissurally flexed primary cusp lacking symphysial denticles or secondary cusps; teeth strongly different between lower M_1 and L_1 and between laterals and post-

teriors of both upper and lower series; lower labials comb-like with a high primary cusp, one to five denticles on the symphysial edge of the primary cusp, and four to nine secondary cusps of ungraduated height; upper laterals smaller than lowers with a single primary cusp, one or two secondary cusps and one or two symphysial denticles; length of crown foot and denticle number increase in size toward commissure in upper laterals; roots undivided, tabular except in posteriors which are dorsoventrally depressed and small; lower and upper posteriors simple, extremely small, elongate with low crown which lacks cusps.

Type Species: Heptranchias cinereus Rafinesque, 1810

Heptranchias howellii (Reed, 1946), new combination

Notidanion howellii Reed, 1946, Notulae Naturae Acad. Nat. Sci. Philadelphia 172: 1-3.

Revised Description of Holotype: Lower left ?fourth lateral tooth possessing five denticles on the symphysial edge of the primary cusp near the crown base. The denticles increase gradually in size toward the cusp apex. The primary cusp is twice as large as sc_1, broad at its base with straight symphysial and commissural edges; and is followed by five secondary cusps; sc_1 and sc_2 are equal in height, sc_3 and sc_4 are taller than the latter two and also equal in height, sc_5 is one third the height of sc_4. The denticles, primary cusp and secondary cusps are inclined commissurally at an angle of approximately fifty degrees. A horizontal line is formed on the lingual tooth surface by the junction of the crown foot and root. A rounded transverse lingual ridge extends the length of the root, approximately 1 mm below the crown base, bending slightly upward at the commissural end and terminated at the symphysial border by a slight dorsoventral depression. The root is tabular, somewhat rectangular and dorsoventrally narrowed toward the commissural end. In cross section the root is wedge-shaped, thickest at its junction with the crown base and tapering toward the posterior root border. The tooth is flat on the labial side, lingually convex. All cusps lack serrations and are "so thin as to be almost translucent; the tooth as a whole is slightly twisted, but the cusps and denticles are set straight on the root, and are not at all sigmoid" (Reed, 1946).

Measurements: Total height 7 mm (measured from the tip of the primary cusp to the root base, perpendicular to the ventral margin of the root); total length 13 mm (measured from the symphysial to commissural margins along the crown foot).

Discussion: Heptranchias howellii differs from H. ezoensis Applegate and Uyeno, 1968, NSMT 7421, in having narrower cusp bases, a narrower and high primary cusp and more than two denticles on the symphysial edge of the primary cusp. A higher

primary cusp and the presence of no more than three denticles on the lower lateral teeth differentiates the extant species H. perlo (Bonnaterre, 1788) from H. howellii.

The Hexanchidae have well developed heterodonty, both along a single tooth series and between upper and lower jaws, with medial, symphysial, anterior, lateral, and posterior tooth types (Applegate, 1965a). Heptranchias perlo has the following dental formula:

LACM F-468, Male:

		P10	L7	A3	S1	S1	A3	L7	P11	
	Left									Right
		P11	L5		M1			L5	P14	

Tooth positions L_1 through L_5 in the lower dentition of Heptranchias perlo (Plate 1) are distinguished by the size and number of cusps, number and arrangement of denticles, height and width ratios, and root morphology. Teeth in the females of H. perlo bear a larger number of secondary cusps than in males of the species (Bigelow and Schroeder, 1948). Confirmation of the presence or absence of this dimorphism in H. howellii and the accuracy of my interpretations of the tooth positions must await the examination of additional specimens when arranged in tooth sets.

OCCURRENCES OF HEPTRANCHIAS HOWELLII

Among the Tertiary selachian assemblages from Oregon, Washington, and British Columbia in the collections at Portland State University, the University of California Museum of Paleontology at Berkeley, the Burke Memorial Washington State Museum, and the Geological Survey of Canada, are six teeth which are referable to Heptranchias howellii.

Oregon

Referred Specimens: PSU F-419, first lower left lateral tooth; UCMP 57456, fourth lower left lateral tooth (Plate 2B).

Formation and Age: Middle member of the Keasey Formation (Schenck, 1927; Warren and Norbisrath, 1946), Lower Refugian (Upper Eocene).

Locality: UCMP loc. V6730, 5' above base of a prominent bluff, during the August low water stage, on W side of Nehalem River, immediately S of the Burn Road Bridge, 0.3 miles S of junction of Oregon State Highways 47 and 202 at Mist, Oregon: NE 1/4 NE 1/4 SE 1/4 Sec. 23, T5N, R5W, Birkenfield Quadrangle (15', 1955), Columbia County, Oregon.

Referred Specimen: PSU F-426, lower right fifth lateral tooth (Plate 2A).

Formation and Age: Nestucca Formation (Snavely and Vokes, 1949), lower Narizian (Bulimina corrugata zone of Mallory, 1959).

Locality: 10' above beach and approximately 100' below a 400' thick flow of basalt, on N shore of Salmon River at Cascade Head, 1/4 mile from mouth of the Salmon River and the Pacific Ocean and 304' N of Teal Creek, in NW 1/4 SE 1/4 Sec. 14, T5S, R11W, Hebo Quadrangle (15', 1955), Tillamook County, Oregon.

Washington

Referred Specimen: UW 60692, anterior half (denticles, primary cusp and sc_1, sc_2) of a lower right lateral tooth with mold of sc_3 - sc_5.

Formation and Age: Lincoln Creek Formation, Echinophoria dalli zone, lower Refugian.

Locality: UW-B0268, Canyon River Section, traverse up-section along the Canyon River from the north in Sec. 18, T21N, R6W, toward the south to Sec. 36, T21N, R6W, Mt. Tebo and Grisdale Quadrangles, (15', 1953), Mason and Grays Harbor Counties, Washington; Loc. CR-7, glauconitic silty sandstone; 3' thick bed with thanatocoenose fauna, in glauconite sand 6' stratigraphically above Loc. UW-CR-6, just above deep pool at SE corner of meander bend, 4700' W, 800' N of SE corner, Sec. 18, T21N, R6W (Personal communication, J. Armentrout, 1974).

Vancouver Island, British Columbia

Referred Specimens: GSC No. 21734 A and GSC No. 21734 B, two lower lateral teeth.

Formation and Age: Jeletzky's "Division C" of Unit 2 of the Tertiary beds of the Hesquiat Peninsula, Vancouver Island (Waldman, 1971), lower Refugian (Sigmomorphina schencki zone) (Cameron, 1971).

Locality: "West coast of Vancouver Island, British Columbia, east side of Hesquiat Peninsula, 0.6 miles (1 km) south of Hesquiat village, 20 yards (18 m) from the beach below high water mark (Waldman, 1971)."

	Measurements	
Specimen Number	Total Height	Total Length
PSU F-419	3.4 mm	6.0+ mm
PSU F-426	7.5+ mm	15.4+ mm
UCMP 57456	9.9 mm	17.0+ mm
UW 60692	9.1+ mm	6.1+ mm
GSC 21734A	-	19.0 mm (Waldman, 197
GSC 21734B		25.0 mm (Waldman, 197

CHRONOSTRATIGRAPHIC DISTRIBUTION OF HEPTRANCHIAS HOWELLII

H. howellii is a minor but characteristic element of the Eocene deep water fish faunas from western Oregon and Washington and southwestern British Columbia. Its chronostratigraphic distribution is presently restricted to strata of Narizian-Refugian age (Fig. 2). Heptranchias howellii first appears in the Bulimina corrugata zone within the upper part of the middle member of the Nestucca Formation (stratigraphic division based upon unpublished data, personal communication, A. D. Callendar, 1974) and its latest occurrence falls within the Sigmomorphina schencki zone of lower Refugian age. This last biostratigraphic zone is represented in stratigraphic Division "C" of Jeletzky (1954) at Hesquiat Peninsula on Vancouver Island, British Columbia, within the lower Lincoln Creek Formation of southwestern Washington (personal communication, J. M. Armentrout, 1973) and perhaps in the upper middle member of the Keasey Formation, Columbia County, Oregon (Fig. 2).

BIOGEOGRAPHY AND PALEOECOLOGY

Upper bathyal to lower neritic sediments of late Eocene age were deposited along the western margin of a tectonically active trench in western Oregon, Washington, and British Columbia (Snavely and Wagner, 1963). Regional subsidence is correlated with the subsequent appearance of bathyal and neritic molluscan, foraminiferal and selachian faunas. The similarity of inferred depositional environments between the Nestucca, Keasey, Lincoln Creek and Vancouver Island sediments (Jeletzky's Division "C") and suggested chronostratigraphic correlation between these formations (Fig. 2) supports this view.

Heptranchias howellii appears to be a geographically limited and narrowly adapted member of the bathyal-neritic fauna in the North Pacific Ocean.

Heptranchias perlo occurs today in waters of the north Atlantic, off South Africa, Australia, and Japan. It is generally considered to be a bottom feeding deep water shark and has been reported at depths of 380 to 460 meters off Portugal and from deep water off Cuba (Bigelow and Schroeder, 1948: 91).

If Heptranchias is indeed a deep water genus then it is not surprising that it should appear in the aforementioned deposits. Moore and Vokes (1953) cited both faunal and lithologic characteristics of the Keasey Formation as indicative of a depth of deposition between 600 and 3,000 feet. A specific depth of 365 m was proposed for the Keasey Formation at Mist, Oregon (UCMP V6730) by Zullo et al. (1964). Welton (1973) listed a selachian fauna for the Keasey Formation at Mist, Oregon that included Notorhynchus, Isurus, Odontaspis, Centrophorus, Squatina, and Pristiophorus. With the exception of Isurus, all of the above taxa are known, on the basis of extant species, to inhabit depths equal to or greater

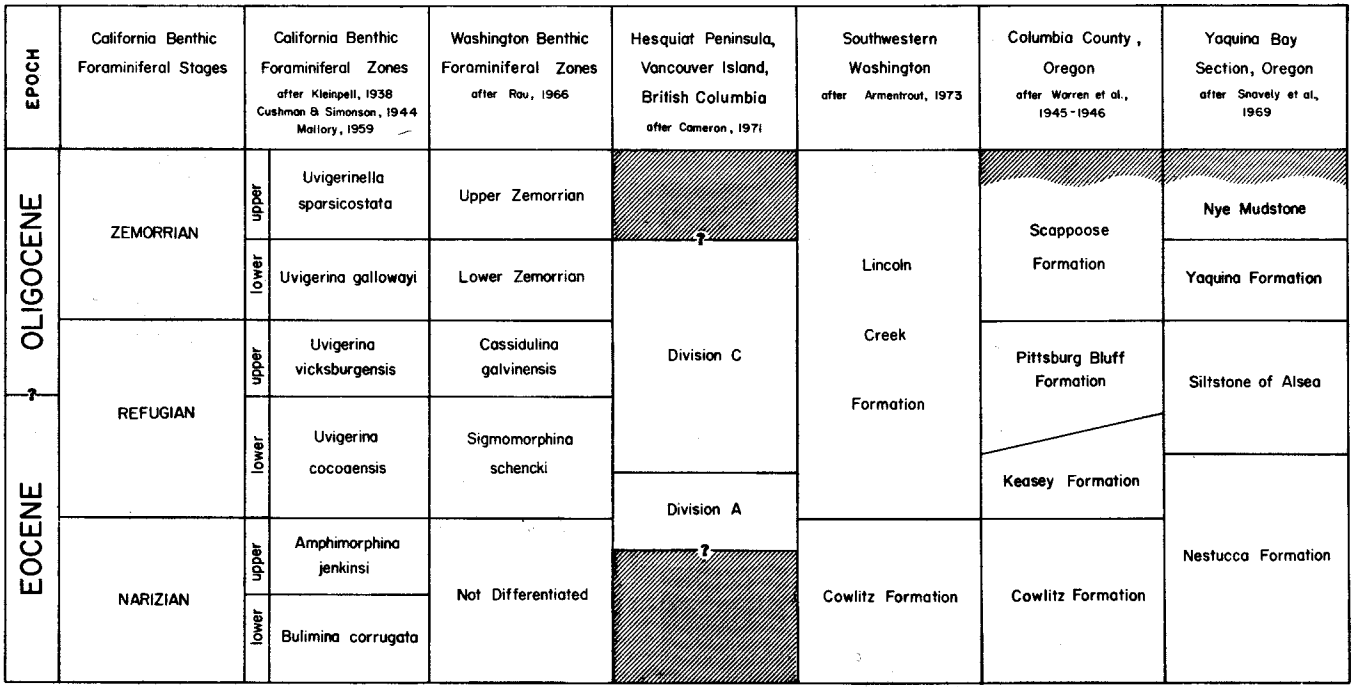
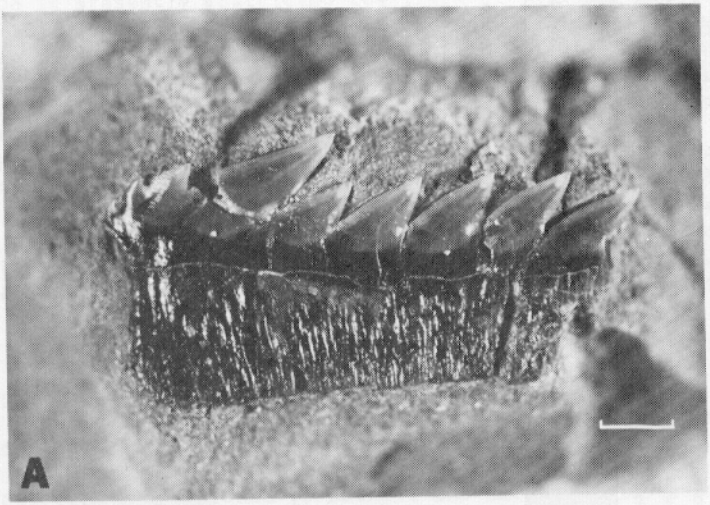


Figure 2. Correlation chart of stratigraphic units discussed in text.


A

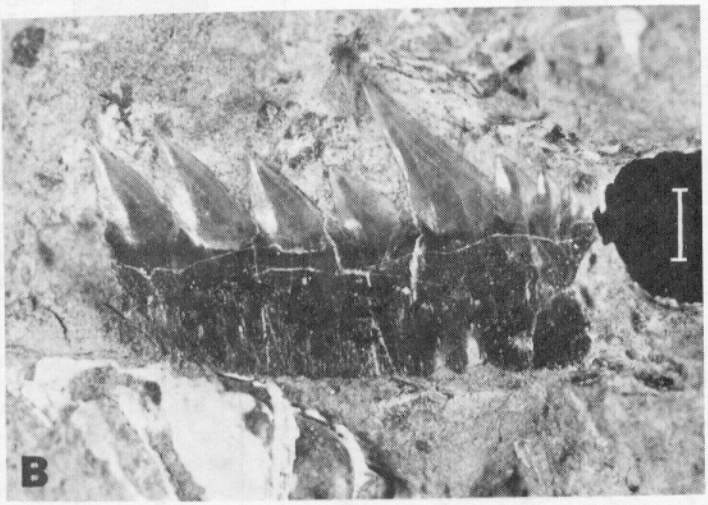

B

PLATE 2. A. Heptranchias howellii, PSU F-426, Nestucca Formation, Tillamook County, Oregon; scale line = 2 mm. B. Heptranchias howellii, UCMP 57456, Keasey Formation, Columbia County, Oregon; scale line = 2 mm.

than 365 m. Armentrout (personal communication, 1973) interpreted the Lincoln Creek Formation at UW locality B-0268 as deposited in middle neritic depths of 30 to 100 fathoms with open marine circulation. The Nestucca Formation of Oregon, at Cascade Head, may have been deposited in waters from 600 to 6,000 feet in depth. This is based upon molluscan and foraminiferal evidence (personal communication, A. D. Callendar, 1974). Cameron (1971) interprets Jeletzky's stratigraphic Division "C" on Hesquiat Peninsula, Vancouver Island, British Columbia, as a deep water deposit.

LITERATURE CITED

Agassiz, L., 1843. Recherches sur les poissons fossiles. 4°, Neuchâtel and Soleure, 3: 1-390.

Applegate, S. P., 1965a. Tooth terminology and variation in sharks with special reference to the sand shark Carcharias taurus Rafinesque. Los Angeles Co. Mus. Contr. Sci. 86: 1-18.

_____, 1965b. A confirmation of the validity of Notorhynchus pectinatus; the second record of this upper Cretaceous cowshark. Bull. So. Calif. Acad. Sci. 64 (3): 122-125.

Applegate, S. P., and T. Uyeno, 1968. The first discovery of a fossil tooth belonging to the shark genus Heptranchias with a new Pristiophorus spine, both from the Oligocene of Japan. Bull. Nat. Sci. Mus. 11 (1): 195-200, 1 pl.

Arambourg, C., 1927. Les poissons fossiles d'Oran. Mater. Carte Geol. Algerie, (I) Paleont., (6): 222-223.

Armentrout, J. M., 1973a. Stratigraphic relationships of the Narizian-Refugian boundary in Washington. Geol. Soc. Amer. Abst. with Programs 5 (1): 4.

_____, 1973b. Molluscan paleontology and biostratigraphy of the Lincoln Creek Formation, Late Eocene - Oligocene, southwestern Washington. Unpublished Ph.D. Dissertation, University of Washington, 2: 479 pp.

Bigelow, H. B., and W. C. Schroeder, 1948. Fishes of the western North Atlantic. Mem. Sears Found. Mar. Res., Pt. 1: 1-576.

Cameron, B. E. B., 1971. Tertiary stratigraphy and microfaunas from the Hesquiat-Nootka area, west coast of Vancouver Island (92E). Geol. Surv. Canada Paper 71-1: 91-94.

Campagno, L. J. V., 1970. Systematics of the genus Hemitriakis (Selachii: Carcharhinidae), and related genera. Proc. Calif. Acad. Sci. 38 (4): 63-98.

Cushman, J. A., and R. R. Simonson, 1944. Foraminifera from the Tumey Formation, Fresno County, California. Jour. Paleon. 18: 186-203, pls. 30-34.

Cuvier, G., 1817. Le règne animal distribué d'après son organisation. 1st ed., Paris, 1: 540 pp.

_____, 1829. Le règne animal distribué d'après son organisation. 2nd ed., Paris, 5 vols.

Garman, S., 1913. The Plagiostoma (sharks, skates, and rays).

Mem. Mus. Comp. Zool. (Harvard) 36: 1-528.
Hickman, C. S., 1972. Review of the bathyal gastropod genus Phanerolepida (Homalopomatinae) and description of a new species from the Oregon Oligocene. Veliger 15 (2): 107-112.
Jeletzky, J. A., 1954. Tertiary rocks of the Hesquiat-Nootka area, west coast of Vancouver Island, British Columbia. Geol. Surv. Canada Paper 53 (17): 1-65.
Jordan, D. S., 1907. The fossil fishes of California with supplementary notes on other species of extinct fishes. Univ. Calif. Publs. Geol. 5 (7): 95-144, pls. 11-12.
Kleinpell, R. M., 1938. Miocene stratigraphy of California. Tulsa, Okla.: Amer. Assoc. Petrol. Geol.: 450 pp., 22 pls.
Leriche, M., 1908. Observations de les Squales neogenes de la Californie. Ann. Soc. Geol. Nord. 37: 302-306.
Mallory, V. S., 1959. Lower Tertiary biostratigraphy of the California coast range. Tulsa, Okla., Amer. Assoc. Petrol. Geol.: 416 pp.
Moore, R. C., and H. E. Vokes, 1953. Lower Tertiary crinoids from northwestern Oregon. U. S. Geol. Surv. Prof. Paper 233-E: 113-147, pls. 14-24.
Pledge, N. S., 1967. Fossil elasmobranch teeth of South Australia and their stratigraphic distribution. Trans. Roy. Soc. So. Aust. 91: 135-160.
Rau, W. W., 1966. Stratigraphy and Foraminifera of the Satsop River Area, Southern Olympic Peninsula, Washington. Wash. Div. Mines Geol. Bull. 53: 66 pp.
Reed, M. D., 1946. A new species of fossil shark from New Jersey. Notulae Naturae Acad. Nat. Sci. Philadelphia 172: 1-3.
Schenck, H. G., 1927. Marine Oligocene of Oregon. Univ. Calif. Publ. Bull. Dept. Geol. Sci. 16 (12): 449-460.
Snavely, P. D., Jr., and H. E. Vokes, 1949. Geology of the coastal area between Cape Kiwanda and Cape Foulweather, Oregon. U. S. Geol. Surv. Prelim. Map 97, Oil and Gas Investigations Ser.
Snavely, P. D., Jr., and H. C. Wagner, 1963. Tertiary geologic history of western Oregon and Washington. Washington Div. Mines Geol., Report of Investigations No. 22: 1-25.
Waldman, M., 1971. Hexanchid and orthacodontid shark teeth from the lower Tertiary of Vancouver Island, British Columbia. Canadian Jour. Earth Sci. 8 (1): 166-170.
Warren, W. C., and H. Norbisrath, 1946. Stratigraphy of the upper Nehalem River basin, northwestern Oregon. Amer. Assoc. Petrol. Geol. Bull. 30: 213-237.
Welton, B. J., 1972. Fossil sharks in Oregon. The Ore Bin, Oregon Dept. Geol. Mineral Industries 34 (10): 161-170, 1 pl.
_____, 1973. Oligocene selachians from the Keasey Formation at Mist, Oregon. Geol. Soc. Amer. Abst. with Programs 5 (1): 121.
Zullo, V., R. F. Karr, J. W. Durham, and E. C. Allison, 1964. The echinoid genus Salenia in the eastern Pacific. Paleont. 7 (2): 331, pl. 56.