

Status report on:

Nat. Aero. and Space Adm. Grant NGR-07-004-034.

Title:

Relationship, through geologic time, of days per lunar month to growth increments in fossil and recent molluscan shells.

For period covering:

September 14, 1967 - March 14, 1968

Report prepared by:

Copeland MacClintock and Giorgio Pannella.

Date:

April 24, 1968

Report:

This report was prepared as a substitute for the section "Periodicity in Fossils" of the paper: - Pannella, G. and MacClintock, C., Biological and Environmental Rhythms Reflected in Molluscan Shell Growth: Paleo. Society, Memoir 2 (erroneously called 1 in second status report). In addition the Plate 8 of this report was substituted for Plate 8 of the original manuscript, and a new table (Table 3) was added.

FACILITY FORM 602

N 68 21776	(ACCESSION NUMBER)	(THRU)
7	(PAGES)	(CODE)
CR 94128	(NASA CR OR TMX OR AD NUMBER)	13 (CATEGORY)

GPO PRICE \$ _____

CFSTI PRICE(S) \$ _____

Hard copy (HC) 3.00

Microfiche (MF) 65



PERIODICITY IN FOSSILS

The above observations constitute the basic knowledge for interpretation of growth patterns in fossil bivalves. In dealing with fossils, however, several major difficulties are encountered. 1) Preservation of growth patterns generally decreases with increasing geological age: the older the fossils the less likely they will show well-preserved, continuous growth records. 2) Bivalves with shell structures which enhance the resolution of growth increments are rare in pre-Mesozoic assemblages. 3) The less clear the growth record, the more subjective is the interpretation of daily increments. 4) The variation since the Pennsylvanian in the number of days per lunar month predictable on theoretic geophysical calculations is so small that subjective bias in counting can adversely affect the resolving power of this method. The figures given in table 3 should be considered with these pitfalls in mind. They are the result of a preliminary survey of bivalves from the Miocene, Eocene, Cretaceous and Pennsylvanian of North America (Pl. 8). For control and comparison, counts of Recent bivalves are shown in the table. The number of days per lunar month ranges between relatively narrow limits: 26 and 35. Only the values from well-developed growth patterns are included in the table; counts of growth patterns clearly incomplete or difficult to interpret have been omitted. Only the averages from lunar-month patterns have been computed

because fortnightly patterns appear to have a wider range of variation. The average number of days per lunar month have been computed for the Recent from 104 counts (3030 days) in 4 specimens, for the Miocene from 16 counts (470 days) in 1 specimen, for the Eocene from 88 counts (2624 days) in 2 specimens, for the Cretaceous from 55 counts (1648 days) in 3 specimens, and for the Pennsylvanian from 119 counts (3578 days) in 4 specimens. Standard deviation and standard error have been computed. It is tempting to interpret the figures as proof of the trend, predicted by the geophysicists, of a decrease in the number of days per lunar month toward the Recent and to emphasize the agreement between the value for the Pennsylvanian (30.07 ± 0.08) and Scrutton's (1964) value for the Devonian (30.59). A look at the means of each specimen, however, invites more prudent speculations. The means range from 28.98 to 29.58 for the Recent, 29.63 to 29.96 for the Eocene, 29.67 to 30.21 for the Cretaceous, and 29.87 to 30.65 for the Pennsylvanian. These ranges overlap and must be supplemented by more data before they will allow an unambiguous interpretation. The data may be supplied not only by bivalves, which doubtfully will yield well-preserved growth records before the Pennsylvanian, but also by other mollusks. In addition to counting increments in cross section, another promising method for studying periodicity in fossils is the analysis of surface topography as has been done with Devonian corals. For example, a cephalopod from the lower Pennsylvanian Kendrick Shale of Kentucky has on its external surface thin growth bands which are arranged in recurrent topographic highs and lows (Pl. 9). Two periodical patterns of 15 and 30 increments are detectable (Table 3). A modern example of the same patterns with a periodicity of 14 or less units, has been found in the cephalopod Nautilus.

Other periodical patterns are recognizable in fossil bivalves. The periodicity of seasonal patterns, which requires a certain number of yearly counts, is still uncertain because not enough continuous growth records in Mesozoic and Paleozoic

fossilshave been gathered. According to Lamar and Merifield (1966), however, it is possible to use tidal and lunar-month patterns, independently from yearly counts, for geochronological calculations. Because these patterns are more likely to be found complete than seasonal ones, fossil mollusks can yield a great deal of data relevant to Earth and life history.

TABLE 3 A (continued)

Upper Cret.	<u>Limopsis</u> <u>striatopunctatus</u>	A-1006 S. Dakota	26322	18	534	$\bar{X}29.67$	± 1.03	± 0.26		
	<u>Cucullaea</u> <u>nebrascensis</u> Owen	A-343, Fox Hills fm. S. Dakota	26381	19	574	$\bar{X}30.21$	± 1.03	± 0.27	29.96 ± 0.98	± 0.13
	<u>Tancredia</u> <u>americana</u> (Meek and Hayden)	A-724, Fox Hills fm. S. Dakota	26382	18	540	$\bar{X}30.00$	± 0.84	± 0.22		
Upper Penna.	<u>Conocardium</u> sp.	A-6505 Oklahoma	26383	17	521	$\bar{X}30.65$	± 0.70	± 0.17		
	"	"	26378	78	2337	$\bar{X}29.96$	± 0.83	± 0.09		
	"	"	26384	15	448	$\bar{X}29.87$	± 0.52	± 0.13		
Lower Penna.	Cephalopod sp.	3449/1 Kendrick Sh. Kentucky	26323	9	272	$\bar{X}30.22$	± 1.20	± 0.40		
Middle Devonian	Tetracorals of Scrutton (1964)			112					30.59	

*This mean is based on both Upper and Lower Pennsylvanian specimens.

Table 3-B

TABLE 3 A The mean number of days per lunar month from Devonian to Recent based on growth-increment counts.

Age	Taxon	YPM-IP loc. no. and/or description	YPM-IP Num. of specim. lunar- month patterns	Tot. num. days	Mean num. increments/ month	Stand. dev.	Stand. error	Mean of all cnts.	Stand. dev.	Stand. error
Recent	<u>Mercenaria</u>	A-7267	26310	25	727	$\bar{X}29.08$	± 1.22	± 0.25		
	<u>mercenaria</u>	Cape Cod								
	"	"	26307	19	562	$\bar{X}29.58$	± 1.35	± 0.37		
	"	A-6843	26304	18	524	$\bar{X}29.11$	± 0.90	± 0.24	29.13	± 1.07
		Cape Cod								± 0.11
	"	"	26305	42	1217	$\bar{X}28.98$	± 0.87	± 0.16		
Upper Miocene	<u>M. campechiensis</u>	A-4633	26376	16	470	$\bar{X}29.38$	± 1.93	± 0.48	29.38	± 1.93
	<u>ochlockoneensis</u>	Florida								± 0.48
Upper Eocene	<u>Crassatella</u>	Vicksburg,	26377	38	1126	$\bar{X}29.63$	± 0.97	± 0.16		
	<u>mississippiensis</u>	Mississippi								
Middle Eocene	<u>Cardita</u>	Claiborne	26380	50	1498	$\bar{X}29.96$	± 0.88	± 0.12	29.82	± 0.93
	<u>planicosta</u>	fm., Bells								± 0.10
	(Lamarck)	Landing, Ala.								

TABLE 3-B

Explanation of Plate 8

Fortnightly cycles of deposition in fossil bivalves expressed by clusters (c) of thin daily increments. Increments are seen more clearly when viewed at a low angle to page surface.

- Fig. 1 - Mercenaria campechiensis ochlockoneensis (Mansfield).
Outer prismatic shell layer; increments at high angle to surface of maximum growth; Upper Miocene, Choctawhatchee formation, 20 mi. west of Tallahassee, Florida; YPM-IP loc. no. A-4633; plexiglass peel; X125; hypotype, YPM-IP no. 26376-p.
- Figs. 2,3 - Crassatella mississippiensis Conrad. Inner part of outer crossed-lamellar shell layer; increments at low angle to surface of maximum growth; Upper Eocene, Vicksburg, Mississippi; plexiglass peels. 2, X125; hypotype YPM-IP no. 26377-i. 3, X200; hypotype, YPM-IP no. 26377-h.
- Fig. 4 - Limopsis striatopunctatus Evans and Schumard. Outer prismatic shell layer; Upper Cretaceous, Fox Hills formation, Dewey Co., South Dakota; YPM-IP loc. no. A-1006; thin section; X400; hypotype, YPM-IP no. 26322-b.
- Figs. 5,6 - Conocardium sp. Outer complex-prismatic shell layer; Upper Pennsylvanian, Vilas? Shale, Wann, Oklahoma; YPM-IP loc. no. A-6506; acetate peels. 5, Outer part of outer shell layer showing relationship between concentric, roofed-over pits and growth increments; X200; hypotype, YPM-IP no. 26378-h. 6, Increments in area where no concentric, roofed-over pits are present; X200; hypotype, YPM-IP no. 26379-d.

