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W. A. NELSON and R. E. DE WREEDE : Reproductive phenology of *Analipus japonicus* (HARV.) WYNNE (Phaeophyta) in the eastern North Pacific

Key Index Words: Analipus—*British Columbia—eastern Pacific—Heterochordariaceae—reproductive phenology.*
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Analipus japonicus (HARV.) WYNNE (Heterochordariaceae, Ectocarpales) grows on rocky intertidal shores in the northern Pacific, from Japan to the Bering Sea and from Alaska to Pt Conception, California (ABBOTT and HOLLENBERG 1976; TOKIDA 1954; INAGAKI 1958). Plants of *A. japonicus* consist of lobed crusts from which develop erect axes bearing either unilocular or plurilocular sporangia. Cytological studies of field specimens have established that plants with unilocular sporangia are diploid, plants with plurilocular sporangia are haploid, and that the site of meiosis is within unilocular sporangia prior to formation of spores (ABE 1936; NELSON and COLE 1981).

Little is known about the phenology of growth and reproduction of *A. japonicus* in the eastern Pacific. In Japan NAKAHARA (1984) found that in the field only the prostrate crusts are present in summer with erect axes developing in winter. Under culture conditions, NAKAHARA (1984) found that erect axes were produced under cool, short-day conditions. The intention of this study was to ascertain the seasonality of reproduction and the ratio of unilocular to plurilocular plants in populations of *A. japonicus* in British Columbia.

Collections of *A. japonicus* were made from 17 sites (Appendix) in southern British Columbia between June 1977 and August 1979. Regular sampling occurred at 3 sites - Bath Is, Strait of Georgia, and Aguilar House Pt and Second Beach, Barkley Sound, Vancouver Is. From each collection of more than 50 erect axes, 25 axes were selected randomly, axis height measured (to nearest mm), and then sectioned to determine reproductive status. From the other 14 sites in British Columbia 42 collections, from all seasons, were examined. All plants of *A. japonicus* collected in British Columbia were either sterile or plurilocular: no specimens with unilocular sporangia were found. Figure 1 illustrates the seasonal variation in the percentage of plurilocular plants in samples from the 3 principal sites. There was considerable variability in the size of erect axes throughout the year with a clear seasonal pattern occurring at each site (Fig. 2). The peak in mean axis height in each population coincided with the maximum levels of fertility. The timing of these peaks, however, varied between populations. Erect axes of *A. japonicus* were found year-round in British Columbia although not at all sites. There was no clear differentiation into winter or summer plant forms.

These field results stimulated a survey of herbarium holdings of *A. japonicus*, the intention being to identify localities or seasons from which unilocular material had been obtained. All holdings of *A. japonicus* from the eastern Pacific were obtained from the following herbaria (379 specimens) and examined for sporangia: UBC, UC, GMS, WTU, MICH, FH, TCD (HOLMGREN *et al.* 1981). Sterile and plurilocular sporangiate plants made up 377 of the 379 specimens examined. The two unilocular specimens came from two closely situated localities in Monterey County California-City Pt, July 1958, GMS 1694 and Pt Lobos, July 1892, UC74617.

Supplementary collections were then made at sites in Washington (3-July, September

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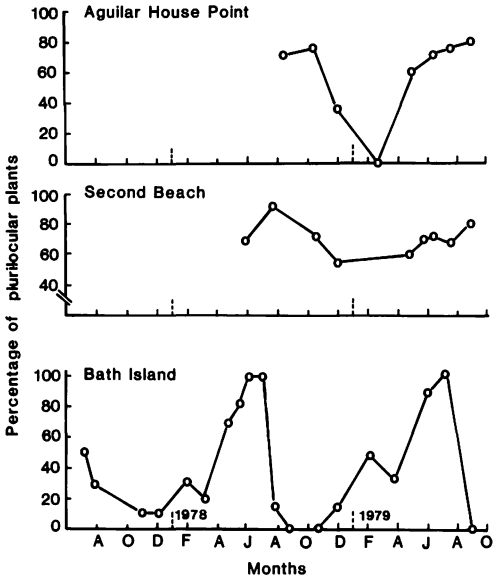

Fig. 1. Seasonal variation in the percentage of plurilocular plants in samples from three principal sites in British Columbia: Aguilar House Pt, Second Bch, Bath I.

1978), Oregon (11-June 1978, March 1979) and California (20-March, September 1979) (Appendix) and this material examined to determine reproductive status. These collections yielded sterile or plurilocular plants from all sites except for a very small population with unilocular sporangia at City Point California. The unilocular plants were growing on the faces of large boulders in the mid-intertidal region. This population was restricted to patches within a zone about 0.75×0.5 m. Plants bearing plurilocular sporangia were abundant at the same site and occupied a greater vertical and horizontal range. Further intensive collections were made in the vicinity of City Pt (G. GIBESAN, University of California, Santa Cruz) but no further unilocular populations were located in the area.

In the eastern Pacific the haploid plurilocular sporangiate phase is clearly the predominant life history state in *A. japonicus*. Unilocular sporangiate plants are rare and the ones found by this study were from a restricted area near the southern distributional limit of this species. The absence or rarity of unilocular plants indicates that asexual reproduction plays a major role in maintaining populations of *A. japonicus* which we sampled, and that sexual reproduction is infrequent or non-existent. CLAYTON (1982) cautions that it is important to be

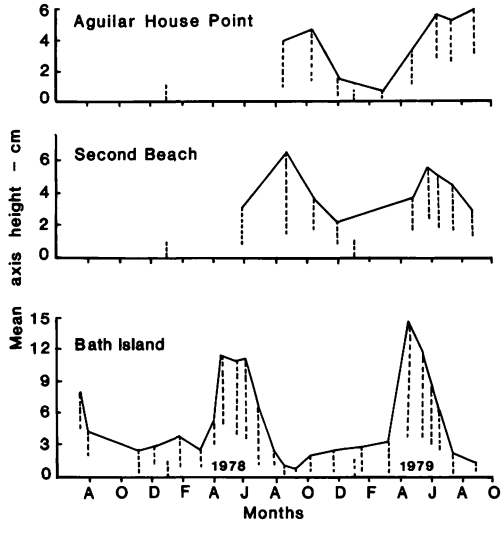

Fig. 2. Mean axis height of plants from three sites in British Columbia. Error bar indicates one standard deviation of mean.

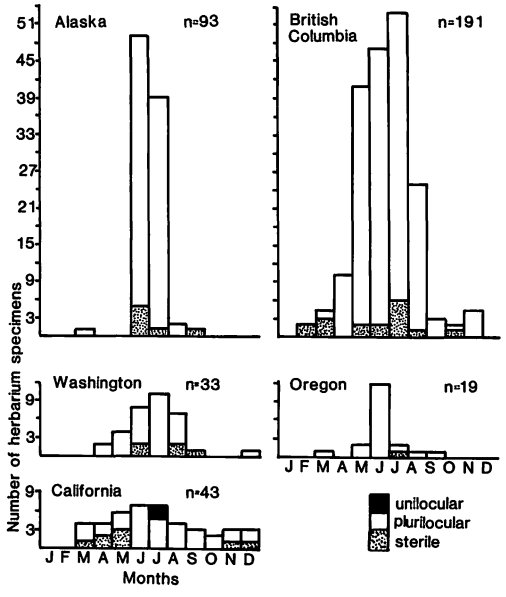

Fig. 3. Results of herbarium survey showing numbers of sterile, unilocular, and plurilocular specimens examined arranged by region and month of collection.

aware of the limitations of sampling methods when attempting to assess the life history of any particular species as gametogenesis is a transient seasonal phenomenon in some species.

The evolution of heteromorphic life histories in the algae has been explained by some workers as a "bet-hedging" strategy, with two phases exhibiting different ecological and physiological responses, presumably conferring more options for survival and evolutionary success (LUBCHENCO and CUBIT 1980; SLOCUM 1980). Although in *A. japonicus* the two caryological phases are isomorphic, within each generation the thallus consists of two functionally different parts - the crust and the upright axes. *A. japonicus* may obtain some of the benefits which accrue to algae with heteromorphic life histories without altering its caryological phase. The following areas warrant further attention - the apparent differences between eastern and western Pacific sites, and, the contribution of unilocular and plurilocular plants to population maintenance at sites where both reproductive states occur.

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APPENDIX - *Collection Sites:*

British Columbia: Aguilar House Pt-48°50′N 125°08′W; Bath I.-49°09′N 123°40′W; Botany Bch-48°32′N 124°27′W; Brady's Bch-48°49′N 125°09′W; Breakwater I.-49°08′N 123°40′W; Diana I.-48°50′N 125°11′W; Haines I.-48°50′N 125°10′W; Helby I.-48°51′N 125°10′W; Pachena Bay-48°51′N 125°20′W; Ross Islets-48°52′N 125°09′W; Second Bch-48°49′N 125°10′W; Seppings I.-48°51′N 125°12′W; Sidney-48°38′N 123°25′W; Sombrio River-48°30′N 124°17′W; Sooke-48°21′N 123°44′W; Victoria Breakwater-48°24′N 123°24′W; Wizard Rk-48°51′N 125°09′W. *Washington*: Cattle Pt-48°27′N 122°58′W; Kalaloch-47°55′N 124°38′W; Mar Vista-48°28′N 123°01′W. *Oregon*: Boiler Bay-44°50′N 124°05′W; Cape Arago-43°19′N 124°24′W; Devil's Punchbowl-44°47′N 124°05′W; Fogarty Ck-44°49′N 124°05′W; Harris Bch-43°10′N 124°20′W; Marine Gardens-44°48′N 124°05′W; Sunset Bch-43°18′N 124°23′W; Yaquina Hd-44°40′N 124°04′W. *California*: Anchor Bay-38°40′N 123°30′W; City (Mission) Pt-36°33′N 121°55′W; Davenport Landing-37°00′N

122°11′W; Montana de Oro-35°20′N 120°50′W; Moss Bch-37°30′N 122°30′W; Pebble Bch-37°20′N 122°30′W; Pescadero Bch-37°25′N 122°28′W; Piedras Blancas-35°39′N 121°17′W; Pigeon Pt-37°15′N 122°30′W; Pt Arena-38°55′N 123°50′W; Pt Joe-36°37′N 121°57′W; Pt Pinos-36°37′N 121°57′W; Stillwater Cove-36°36′N 121°56′W; Trinidad Pt-41°05′N 124°10′W; Westport-39°38′N 123°46′W.

W. A. NELSON* · R. E. DE WREEDE : 東部北太平洋における褐藻マツモの生殖の季節性**

カナダのブリティシュコロンビアにおける褐藻マツモの生殖の季節性および個体群内の単子嚢をもつ個体と複子嚢をもつ個体の比を調べた。マツモの直立体はブリティシュコロンビアでは多くの地域で一年中見られ，主軸長の平均値がピークになる時期と成熟のレベルが最高になる時期とは一致したが，ピークになる時期は個体群によって異っていた。東部太平洋地域で採集された379腊葉標本中には複子嚢をもつ個体が377あった。補足的な採集も行って検討した結果，東部太平洋地域では単子嚢をもつ個体はまれで，複子嚢をもつ単相世代が優占していることが分った。(*National Museum of New Zealand, P.O. Box 467, Wellington, New Zealand; **Department of Botany, University of British Columbia, Vancouver, B.C., V6T 2B1, Canada)