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**GOOSE BARNACLES  
(CIRRIPEDIA: THORACICA)  
ON FLOTSAM BEACHED AT  
LA JOLLA, CALIFORNIA**

The macroscopic floating biota of the ocean surface—the pleuston—has been comparatively little studied (see review by Cheng 1975). It comprises a few species of insects, which skim over the surface; a few species of siphonophores equipped with floats; a few species of barnacles; etc. These organisms can be collected by the use of special nets towed at the level of the ocean surface, but the numbers of such tows made on oceanographic expeditions have been comparatively few compared with the much larger numbers of plankton tows made below the sea surface. Under exceptional circumstances, when an onshore wind blows for an extended period, pleustonic organisms are cast ashore in appreciable numbers, presenting unusual opportunities to study numbers of individuals of this little known community. Such mass beachings of the siphonophores *Physalia* and *Velella* have been reported in several parts of the world (Bingham and Albertson 1974; Cheng 1975). This paper presents some data on a mass beaching of pleustonic goose barnacles, mostly attached to floating objects and mostly still living, found washed ashore between 5 and 9 July 1974,

in front of the Scripps Institution of Oceanography, La Jolla, Calif.

**Methods**

A stretch of beach approximately 1 km long and 5 m wide was searched systematically for five successive days, around the time of the low tide in daylight, and every barnacle or piece of flotsam bearing barnacles was collected, taken to the laboratory in plastic bags, and there kept in tanks with running seawater. Some observations were made on the living animals, which remained alive, feeding actively, for several days, and specimens were photographed (Figure 1A-F). They were sorted according to substrate, the species were identified, and the lengths of the capitula were measured from base of scutum to apex of tergum (peduncle lengths being variable).

**Observations**

In all, some 329 substrate objects were collected and examined; they bore a total of 2,555 individual barnacles. The data, for all collections, are summarized in Tables 1 and 2, and the size distributions of each species on each of the major substrate types are shown in Figure 2A-L. The following generalizations were made on the basis of this material.

TABLE 1. — Numbers and percentages of substrates bearing barnacles: *Lepas* (*Dosima*) *fascicularis* and *Lepas* (*Lepas*) *pacifica*.

Substrates	Total Number Dosima + Lepas	<i>Dosima</i>		<i>Lepas</i>		% of total specimens	
		No.	%	No.	%	<i>Dosima</i>	<i>Lepas</i>
Feathers	878	657	75	221	25	34	34
Sea grass leaves:							
<i>Phyllospadix</i>	537						
<i>Zostera</i>	373						
Subtotal	910	835	92	75	8	44	12
Brown algae:							
<i>Macrocystis</i>	202	117	58	85	42	6	13
<i>Colpomenia</i>	18						
<i>Egregia</i>	3						
<i>Haldrydys</i>	55						
<i>Sargassum</i>	6						
<i>Scytosiphon</i>	2						
Subtotal	84	83	99	1	1	4	0
Terrestrial debris:							
Wood	69						
Peanut shells	2						
Plastic straws	9						
Cigarette filters	5						
Subtotal	85	47	55	38	45	3	6
Tar lumps	322	113	35	209	65	6	33
None	74	61	82	13	18	3	2
Total	2,555	1,913	75	642	25	100	100

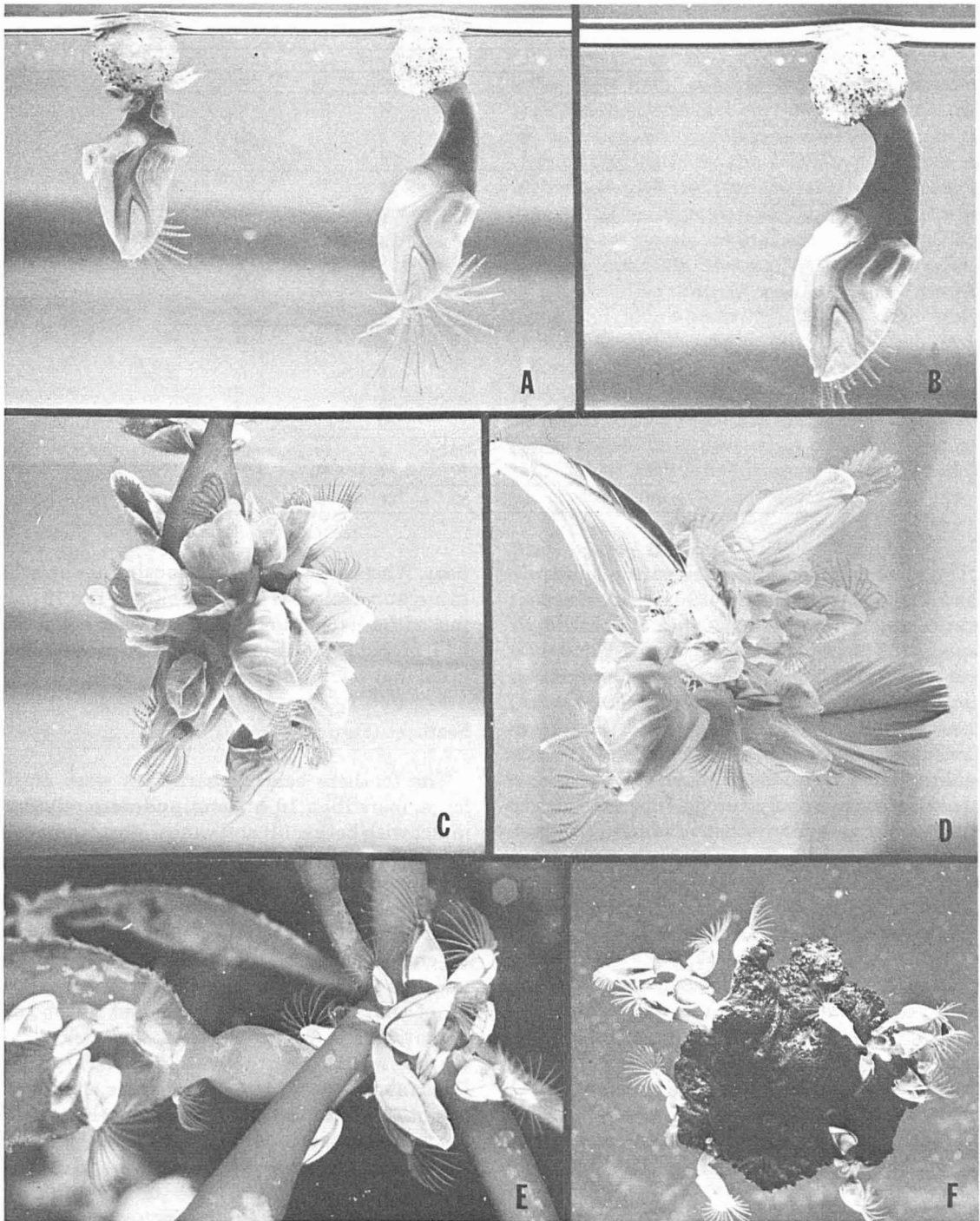


FIGURE 1.—*Lepas (Dosima) fascicularis* and *Lepas (Lepas) pacifica*, living specimens photographed in aquarium. A. Specimens of *Dosima* supported by their own floats at the water surface (note young barnacles attached to specimen on left); B. Right-hand specimen, from Figure 1A, showing cirri withdrawn; C. *Dosima* on detached float of *Macrocyctis*; D. *Dosima* on feather; E. Goose barnacles, mostly *Lepas*, on piece of *Macrocyctis*; F. Small specimens of *Lepas* on flat lump of tar.

TABLE 2.—Numbers and percentages of barnacles [*Lepas (Dosima) fascicularis* and *Lepas (Lepas) pacifica*] on various substrates.

Substrates	<i>Dosima</i> only		<i>Lepas</i> only		<i>Dosima</i> + <i>Lepas</i>		Total of substrates	
	No.	%	No.	%	No.	%	No.	%
Feathers	41	45.5	7	8	42	46.5	90	27
Sea grass leaves:								
<i>Phyllospadix</i>	76		2		8		86	
<i>Zostera</i>	22		1		13		36	
Subtotal	98	80	3	3	21	17	122	37
Brown algae:								
<i>Macrocystis</i>	11	55	0	0	9	45	20	6
<i>Colpomenia</i>	5		0		0		5	
<i>Egregia</i>	1		1		0		2	
<i>Halidrys</i>	9		0		0		9	
<i>Sargassum</i>	1		0		0		1	
<i>Scytosiphon</i>	2		0		0		2	
Subtotal	18	95	1	5	0	0	19	6
Terrestrial debris:								
Wood	8		3		6		17	
Peanut shells	2		0		0		2	
Plastic straws	0		1		0		1	
Cigarette filters	1		0		0		1	
Subtotal	11	52	4	19	6	29	21	7
Tar lumps	14	25	24	42	19	33	57	17
Total	193	59	39	12	97	29	329	100

The most common barnacle-bearing substrate was found to be bird feathers (90 items). The next most common were leaves of the surfgrass *Phyllospadix* (86 pieces) and tar (57 lumps). Other substrates included bits of brown algae *Colpomenia*, *Egregia*, *Halidrys*, *Macrocystis*, *Sargassum*, *Scytosiphon*; leaves of the sea grass *Zostera*; pieces of wood; cigarette filters; peanut shells; and plastic drinking straws. (Pieces of other debris without barnacles, such as polystyrene cups and plastic bottles and caps—many clearly of local origin—were not collected and are not further discussed here.)

Most of the barnacles belonged to two species: *Lepas (Dosima) fascicularis* Ellis and Solander, the soft blue barnacle (about 75% of the individuals); and *Lepas (Lepas) pacifica* Henry, a common Pacific goose barnacle (about 25%). Two other species of barnacle were also found: three specimens of *Tetraclita squamosa* on pieces of *Macrocystis* stipe, and one young specimen of *Lepas (Lepas) anatifera* on a piece of tar. These have not been included in the data of Tables 1 and 2, and will not be considered further.

#### Unattached (Figure 1A, B)

An appreciable number of the *Dosima* specimens (61) were found unattached to flotsam, either occurring singly, each with its own float, or else with several specimens sharing a communal

float. Whether these had previously been attached to any substrate was not determined. The 13 unattached *Lepas* specimens found in our collections had probably become detached from substrates after they were collected.

#### Feathers (Figures 1D, 2A, B)

The feathers bearing barnacles were mostly large, more than 10 cm long, and were relatively intact with both quill and vanes. Most were white or grey; the species of seabirds from which they originated were not identified. Though a few of the barnacles were attached singly along the shaft, most occurred in clusters, generally near the distal end of the feather. Such clusters comprised as many as 20 individuals of different sizes, many or all of which must have contributed to the communal bubble floats which in some specimens reached a diameter of almost 20 mm. The largest *Dosima* specimen found on a feather was 20 mm long; the largest *Lepas*, only 13 mm. About 50% of the feathers bearing barnacles had only *Dosima* specimens; only seven (7.8%) were found carrying *Lepas* alone, and on all of these the barnacles were rather small and few. On the feathers that carried a mixture of both species, the majority of the animals were *Dosima*; in fact, some 18 of the *Lepas* specimens (all less than 10 mm) were found attached to the larger individuals of *Dosima*. The highest cluster numbers found on single feathers

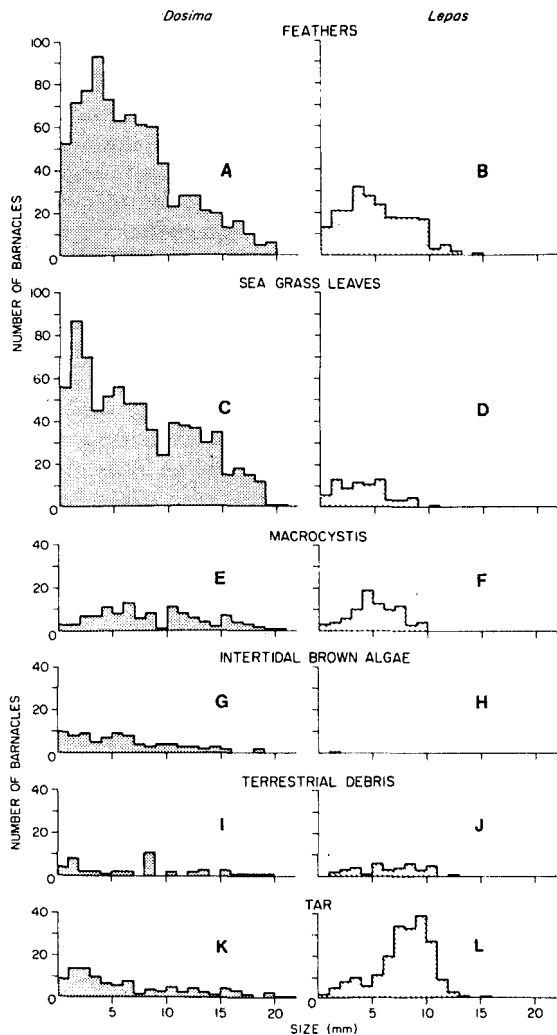


FIGURE 2.—Size-frequency distributions of *Lepas (Dosima) fascicularis* and *Lepas (Lepas) pacifica* on various substrates as indicated.

were 34 for *Dosima* and 15 for *Lepas*. Thirty-six of the *Dosima* clusters consisted of more than 10 individuals, whereas only six of the *Lepas* clumps on feathers comprised more than 10 animals. From these data it appears that on feathers *Dosima* is much commoner than *Lepas* and can occur more densely and in larger clumps, presumably because of its ability to produce its own float.

#### Sea Grass Leaves (Figure 2C, D)

Many of the *Phyllospadix* and *Zostera* leaves bearing barnacles had been completely bleached;

possibly they had become detached from the parent plants and had drifted out to sea before being colonized. The majority of the leaf sections collected were found to carry one or more specimens of *Dosima*. Almost 80% carried only *Dosima*; only 3% bore *Lepas* alone; the rest had both. As in the case of the feathers, the *Dosima* specimens attached to leaves had produced their own floats, as many as 23 individuals being found in one cluster. The largest specimens of *Dosima* found on *Phyllospadix* and *Zostera* were 22 mm and 19 mm long, respectively. In contrast, on these substrates the *Lepas* individuals generally occurred either singly or in pairs, and the majority of these animals did not measure more than 5-6 mm in length, though a few of those which occurred together with *Dosima* exceeded 10 mm. Presumably, larger specimens of *Lepas* cannot be supported by a floating leaf section unless additional buoyancy is supplied by floats of *Dosima*.

#### Brown Algae (Figures 1C, E, 2E-H)

It is significant that the only algae found bearing barnacles are parts of brown algae (Phaeophyta), which either produce well-differentiated gas-filled floats or, as in the cases of *Colpomenia* and *Scytosiphon*, have hollow thalli usually filled with air. The majority of the barnacles were found on float-bearing segments of *Macrocystis*, and in Tables 1 and 2 the data for this alga, which occurs in offshore waters, are presented separately from those of other brown algae, which are more or less intertidal. Since none of these algae normally carry goose barnacles while growing in their natural habitats, it appears probable that the pieces of thallus were colonized by barnacles after they had been detached. They must have floated for some time, however, since the barnacles had reached appreciable sizes: up to 21 mm in length for *Dosima* and up to 12 mm in length for *Lepas*. With the exception of one piece of *Egredia* bearing a small 2-mm *Lepas*, the littoral brown algae bore only *Dosima* (83 specimens in all), whereas a large proportion of the *Macrocystis* pieces bore mixed populations.

#### Terrestrial Debris (Figure 2I, J)

The majority of the fragments grouped in this category were pieces of wood, which may be considered a "natural" substrate since fallen branches are a normal component of the flotsam carried

by rivers out to sea. So far, plastics—in pieces sufficiently large and buoyant to support goose barnacles—evidently constitute a substrate of only minor importance for this kind of animal.

### Tar (Figures 1F, 2K, L)

The 57 pieces of barnacle-bearing tar, presumably originating from natural seepage or oil bunkers, were mostly flattened 2-3 mm thick, 10-60 mm in diameter. This substrate, unlike those described hitherto, appeared to be preferred by *Lepas*. More than 42% of the lumps collected bore only this species, and many of the pieces had more than 10 animals attached. About 65% of the barnacles found on tar were of this species. Some were more than 15 mm long. They were generally not clumped, but occurred scattered over the surface of the substrate, often on both upper and under surfaces, suggesting that the lump had repeatedly turned over while afloat on the ocean. Comparatively fewer of the tar lumps bore only specimens of *Dosima*, and only 10 of these had more than 10 animals each. Per unit of surface area, the individuals of *Dosima* appeared to be more sparsely distributed on tar than on feathers or grass leaves.

### Discussion

*Lepas (Dosima) fascicularis* is the most specialized pleustonic goose barnacle, with an almost uncalcified shell and a gas-filled bubble float. The larval stages were described on the basis of material collected and reared during the *Challenger Expedition* (Willemöes-Suhm 1876). Since there were several errors and omissions in that paper, all the stages were redescribed by Bainbridge and Roskell (1966).

Boëtius (1952-53) reported that all of the specimens of *Dosima*, which he found on the Danish North Sea coast in September 1952, had floats roughly proportional in diameter to the length of the animal. These barnacles are able to support themselves in the adult stage by their own float, but the cyprid larvae must settle on some substrate before they can metamorphose. The larvae of *Dosima* have been shown to settle preferentially on small floating objects; only later do they produce a bubble float which enables them to stay at the sea surface even when detached from such a support (Boëtius 1952-53; Newman 1974). In our collections, all of the *Dosima* specimens, but none of the *Lepas* specimens, were attached to bubble

floats of their own making. Some 27 individuals of *Lepas* (1-10 mm), the smaller of the two species, were found attached to larger specimens of *Dosima*, but, despite their larger absolute numbers, only 8 *Dosima* specimens (1-14 mm) were found on other animals of this species. Evidently floating barnacle colonies do not normally grow by accretion in this way.

The blue pigment of *Dosima* was studied by Fox et al. (1967), who reported that it is a conjugated carotenoid. Although many of the blue barnacles which they studied (washed ashore in the same location) were found attached to the floats of *Velevella*, and although we have found large numbers of these siphonophores stranded at various other times in recent years, we found no *Velevella* floats among the barnacle substrates in this study. In fact, although hundreds of pleustonic barnacles were stranded on our beach during the period studied, we found no specimen of *Physalia*, *Velevella*, or *Ianthina*, which are all common components of the pleuston community in the open ocean. We found only one *Glaucus* (a pelagic nudibranch), a few specimens of *Fiona* (another nudibranch, normally associated with *Macrocystis*), and several polychaete worms. This probably indicates the relatively nearshore rather than oceanic origin of the barnacle colonies. Although, when brought back to a laboratory aquarium and given fresh running seawater, many of the specimens remained alive and apparently healthy for more than 1 wk, such stranded animals are normally unable to return to the sea. When exposed to the sun on the beach they would probably be eaten by gulls or dry up within a few hours.

We have not attempted to study the gut contents of our animals but assume that, like other barnacles in nature, they probably feed mainly on microorganisms and small zooplankton (Howard and Scott 1959; Crisp and Southward 1961). We noted that in the laboratory, when supplied with a suspension of the unicellular alga *Platymonas*, many individuals of *Dosima* extended their cirri, apparently moving them towards the food source, directing it towards the mouth.

Goose barnacles are hermaphrodites. Adults develop both male and female organs at the same time and can cross-fertilize each other. The eggs are brooded in the mantle cavities, and hatch as larvae which live in the plankton before settling. They attach themselves to a solid substrate by an adhesive secreted by the cement glands; the composition of the cement of *Lepas fascicularis* has

been analyzed by Barnes and Blackstock (1974). We do not know how long it takes for them to reach the adult stage after metamorphosis. Horn et al. (1970), who collected 150 specimens of *Lepas pectinata*, 2-8 mm long, attached to four lumps of tar found floating on the sea surface, noted that, in the laboratory, these animals increased in length by about 1 mm per week. The larger specimens in our collections (20 mm for *Dosima*, 15 mm for *Lepas*) contained mature eggs. We have no information on the numbers of generations in the year; our size distribution data (Figure 2) show no evidence for separate generations (which might have been indicated by distinguishable size-class modes). *Lepas* species are known to be widely distributed from tropical to polar seas. Our specimens probably came from populations floating in the eastern Pacific Ocean, which is the most likely area affected by the anomalous meteorological conditions occurring during June and July 1974 (J. Namias, pers. commun.).

### Summary

A total of 1,913 specimens of *Lepas (Dosima) fascicularis* and 642 specimens of *L. (Lepas) pacifica*, many still alive, were collected on a 1,000-m stretch of beach at La Jolla between 5 and 9 July 1974. They were attached to various substrates which had enabled them to float at the sea surface before being cast ashore. The predominant substrates were feathers (90 pieces, bearing 657 *Dosima*, 221 *Lepas*), sea grass leaves (122 pieces: 835 *Dosima*, 75 *Lepas*), brown algae (39 pieces: 200 *Dosima*, 86 *Lepas*), and tar (57 pieces: 113 *Dosima*, 209 *Lepas*). *Dosima* is the predominant species on most of the substrates whereas tar lumps appeared to be preferentially settled by *Lepas*. The size distributions (*Dosima*, 1-22 mm; *Lepas*, 1-16 mm) provided no indications of generational discontinuities. The beaching of these normally pleustonic animals should be considered in relation to preceding and prevailing wind conditions.

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