AN ABSTRACT OF THE THESIS OF

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In books and collections of papers on marine life of the Pacific Coast of North America relatively little reference is made to the animals of the littoral zone of the Oregon Coast. One of the interesting groups of animals found here that has not been the subject of intensive study is the isopods.

Twenty-five species representing sixteen genera of isopods were collected during a study of the Oregon Institute of Marine Biology, and as many of the ecological aspects as possible were recorded. It was found that there were more species of isopods living on the attached algae than under any other conditions. In total numbers, however, more animals were found under conditions that offered better protection, such as under mussel beds, under rocks, and on the rocky cliffs above the water.

Most isopods are of little economic importance except as they may become food for forms that are used by man. Some however are parasites, and others damage the pilings of the docks.

Marine isopods live under various environmental conditions. Some are almost terrestrial, living out of the water entirely, and others are a little more closely associated with the water by living in the sand of the beach. Some live on attached algae, and others on floating algae. Still others are hidden under the mussel beds while many make their homes under rocks. The shore line south of Coos Head is an excellent collecting area because all of these conditions of environment may be found there.

While the members of the class Crustacea are essentially aquatic, isopods are the most successful members of the group in their adaptations toward land life. This is especially indicated by the structure of their breathing apparatus which consists of modified abdominal appendages called pleopods. In the aquatic forms the pleopods function as gills, while in the terrestrial forms tracheae ramifying through them for air breathing. Modification of this is noted in one genus, a species of which is found on the Oregon Coast. It forms a group of isopods that seem to be in a transitory stage of migration from an aquatic to a terrestrial existence. The members do not live in the water but must be near enough so they can moisten their pleopods from time to time. There are numerous species of land isopods that live a terrestrial existence

even though they inhabit moist places. One of these is dealt with in the thesis. There are indications that a migration towards land life is accomplished by a change in the structure of the animal other than just the pleopods. This is especially noted in the form of the uropoda. Those animals along the Oregon Coast which have a terminal uropoda either are terrestrial, partly terrestrial or live in some specialized habitat other than the water.

A key to the species found in the Coos Bay region is included along with a description of each species.

A STUDY OF MARINE ISOPODS OF THE COOS BAY REGION

by

GILBERT MARSHALL SHEARER

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A STUDY OF MARINE ISOPODS OF THE COOS BAY REGION

INTRODUCTION

In books and collections of papers on marine life of the Pacific Coast of North America relatively little reference is made to the animals of the littoral zone of the Oregon Coast. The fauna of the California Coast to the south and that of Puget Sound to the north are much better known. Although the Oregon Coast has many forms of animal life common with those of these better known regions to the north and to the south, there is evidence that it may be a region in which there is an overlapping of the faunas theretofore thought to be limited either to the San Francisco Bay region or to that of Puget Sound. With the recent establishment of the Institute of Marine Biology by the Oregon State Board of Higher Education some progress has been made in determining the animal and plant life of the Coos Bay region, and it is hoped that the investigations may be extended to other parts of the coast of the state. There is ample evidence that the animals of the littoral zone of the Oregon Coast are abundant both in species and individuals.

One of the interesting groups of animals which does not seem to have been the subject of intensive study in this area is the isopods. Richardson (1905) and others have made cursory references to isopods found along the Oregon Coast, but no indication has been found that any detailed taxonomic and ecological study of them has been made in this region. It is the purpose of this paper to describe such a study, especially of those representatives found in the Coos Bay region.

This study was begun during the summer of 1940 and has been continued since. Collections and identifications have been made; environmental relationships noted; and the presence or absence of different species determined at different times during the progress of the study. Except for a very few species population counts could not well be made and so this phase of the investigation has not been generally attempted.

BIOLOGICAL CONSIDERATIONS

Most isopods are of little economic importance except as they may become food for forms that are used as food by man. However one form, Limnoria lignorum, one of the five known species of the genus, is found along the Oregon Coast where it destroys untreated wood pilings. Considerable investigation has been carried on concerning its habits and

economic importance in the San Francisco Bay region (Kofoid 1927), but little reference has been found to similar work done north of that locality.

Isopods, with but few exceptions, are carnivorous animals (Lankester 1909). Examinations of the stomach content of members of the genus Sphaeroma indicate that they are vegetable eaters (Kofoid 1927), and a similar examination of Limnoria (Kofoid 1927) shows their diet to be solely of cellulose. Miller (1938) reports that certain species of isopods feed on decaying organic matter, and that others kept in the laboratory resort to cannibalism.

Isopoda is an order of the subclass Malocostraca, of the class Crustacea. While members of the entire class are essentially aquatic, isopods are the most successful members of the group in their adaptations towards land life (Abbott 1940). This is especially indicated by the structure of their breating apparatus which consists of the modified abdominal appendages called pleopods. In the aquatic forms the pleopods function as gills. They consist of thin lamellar plates through which the dissolved oxygen of the water can diffuse. There are some land forms which use this method of respiration, in which case provision is made for keeping the pleopods moist. These isopods are limited therefore to moist habitats, (Miller 1938). This author also calls attention to the interesting

fact that the animals molt by halves. The posterior molt starts with the fourth thoracic segment, and this is followed in a few days by the anterior molt. The animals remain active, unlike many crustaceans for the entire duration of the molt. This together with the dorso-ventral flattening which makes it possible for them to hide in crevices, enables them to adapt themselves to land life (Abbott 1940).

Packard (1886) states that "The lowest form of isopods are those that are parasitic. From isopods, the next group lower are amphipods which are connected with the shrimps through a group of forms, some of the fossils of which are found in coal formations in Illinois and Europe." However, Packard's contention, that parasites are the lowest form is not held by all scientists. Hegner (1937) says that "The parasitic habit must be more recently evolved than the free-living habit, since free-living forms must have existed before the parasites could obtain hosts on which to live." This seems to be the general opinion on the subject.

It is not easy to make a statement as to the phylogenetic history of isopods because of the lack of fossil forms that can be said for a certainty to belong to this order. There is one fossil belonging to the Denovian period that is regarded, "with considerable probability," as being an isopod (Lankester 1909). There are a few other

fossils that resemble the isopods in some respects and there are several genera of Sphaeromidae and Oniscodea that have been described from Tertiary deposits. Isopods according to Lankester (1909) represent a divergence from the caridoid type, which would agree with Packard (1886) that they came from a shrimp-like ancestor.

In general the sexes are separate in isopods. Sexual dimorphism is quite strongly evident in Ligia pallasii. There are cases of hemaphroditism especially in the parasitic forms, (Lankester 1909). In this same article mention is made of the fact that isopods are typical Crustaceans in that they carry the eggs during incubation. Some of the terrestrial isopods have even developed to the point that the young are nourished in the brood pouch of the female by the secretions of glands.

Besides the detailed study of Limnora lignorum references are made in ecological literature (Pearce 1939 and Allee 1932) to isopods in relation to other animals. The reference may be to one of food relationships of isopods to other animals or those of parasite to host. The isopods are usually the parasites. Different papers have been written on investigations of forms found in Washington and California. Holmes and Gay (1909) described four new species found along the coast of California, while a few years later Stafford (1912-1913) made a report on studies

of isopods found at Laguna Beach. This publication gives an account of isopods in general, written in a rather popular style, and then describes twelve species that are found in that locality. Barrow (1919) made a study of rockboring forms at San Francisco Bay, and Maloney (1933) added two new species for California. Dr. M. A. Miller has made a number of contributions to our knowledge of isopods in his various publications. In 1938 he made an ecological study of terrestrial forms found in the San Francisco Bay region. He includes an artificial key to the terrestrial isopods found here. In collaboration with Dr. Hoy (1939) he made studies concerning the growth and evolution in a subterranean form. In a more recent paper (1940) he deals with the "Isopod Crustacea of the Hawaiian Islands." Abbott (1940) made a study of the "niches occupied by shore isopods and their transition toward land life." To the north Fee (1936) made a study of the isopods, in Canada at Departure Bay. He included with this publication a key to the forms found in this region. Dailey and Hatch (1940) described two species of terrestrial isopods from Washington. This was a short account published in the American Midland Naturalist, describing the two species.

A survey of the above cited literature indicates that there is still much to learn about isopods, their habits,

life histories, relationships with other organisms, both plant and animal, and their economic importance. And it is especially noticeable that very little study has been made of forms found along the Oregon Coast. It was with these points in mind that the present study was undertaken.

Hall (1913) with no particular reference to isopods, mentions the fact that animals are more plentiful some years than others. This fact was also established in studying the isopods at Coos Head. During the summer of 1940 the number of Ligia pallasii found on the rock cliffs near Squaw Island, about three miles south of Coos Head, were very numberous during the early morning hours. Although actual population counts were not made several collecting trips the next summer at about the same hours of the day showed these animals noticeably less abundant than they were the year before. The same thing was true with Argeia pugettensis which is parasitic in the branchial cavity of the shrimp Crago. During one summer nearly half of the shrimp collected by the Invertebrate Zoology class of the Oregon Institute of Marine Biology and other workers, were infested, while the following summer only three out of forty were found with the parasite.

Marine isopods of the Oregon Coast live under various environmental conditions. Some are almost terrestrial and are found high on the rock cliffs, and others have to be

dredged from the bottom of the ocean. Some burrow in the sand of the beach, while others live hidden among the mussels and barnacles on exposed rocky shores pounded hard by the waves. A number of species cling to bits of algae floating in the surf--in fact there are times when almost every small piece of algae has at least one or two specimens on it. Various small forms seem to live at times in the trash that is washed up on the beach, but it is evident that this is not their permanent home because they can not always be found here. Just where their home is at other times is not known. During one summer some isopods were quite abundant, while during the next they could not be found. Members of the genus Pentidotea are sometimes found under rocks, but are more often found clinging to algae, the color of which they closely resemble.

Data concerning the salinity of the water were supplied by Mr. J. C. Queen, Instructor in Science at Marshfield Oregon High School. These were found to vary only a small fraction of a gram per liter in the whole area studied. This statement would indicate that salinity was of little or no importance in the distribution of the Isopoda found there.

GENERAL DESCRIPTION OF A TYPICAL ISOPOD

The accompanying diagram will show the external parts of an isopod. Adult specimens vary in size from less than 1 mm in length to the largest which may measure as much as 90 mm.

The head varies in size and shape but in general is similar to that of other crustaceans. It has the usual mouth parts, i.e. mandibles maxillae, and maxillipeds. In a complete key such as the one by Richardson (1905) the mouth parts are diagnostic and must be removed and viewed under the microscope in order to make identification.

There are two pairs of antennae and in general the first pair is the smaller, sometimes being only one or two articles in length.

The body is generally flattened dorso-ventrally. The thorax is normally composed of seven segments with their lateral margins sometimes produced in plate like processes called epimera. There are normally seven pairs of legs, one pair on each thoracic segment. The first pair in some species is chelate, but only one of these forms was found during this study.

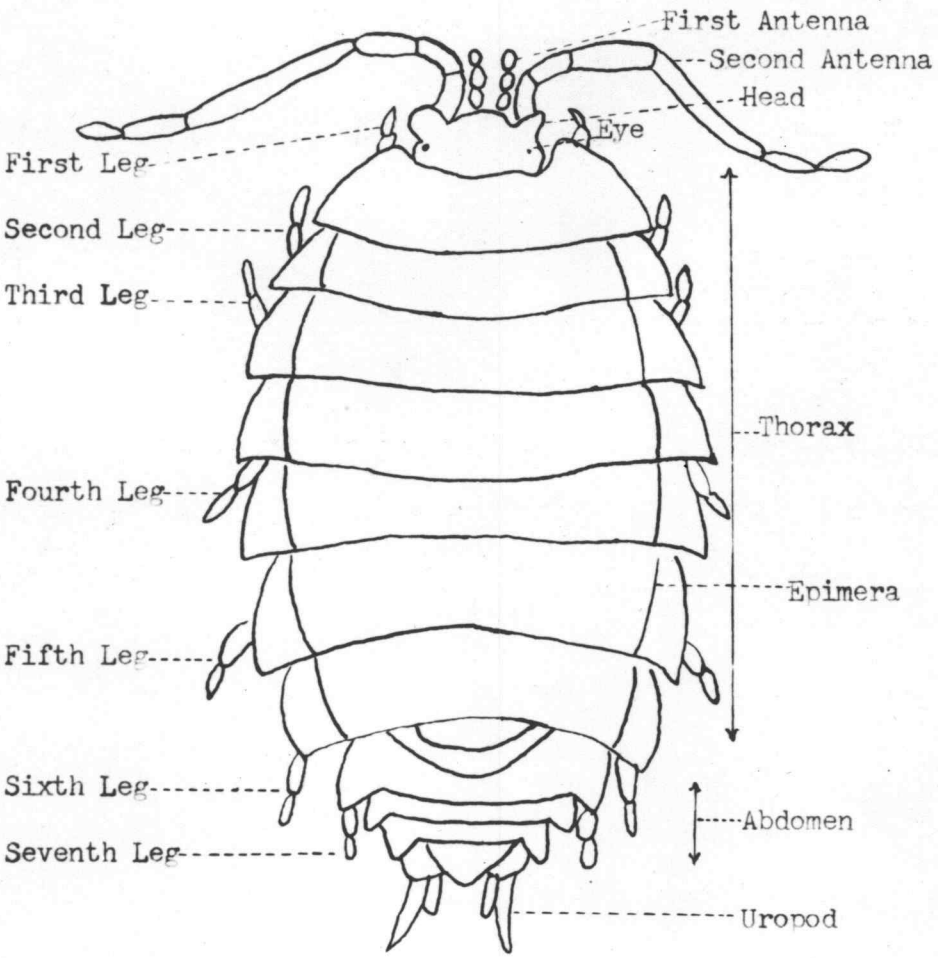
The abdomen is normally composed of six segments. In some cases they have become fused until only one is apparent in the adult. In other instances there may be two or

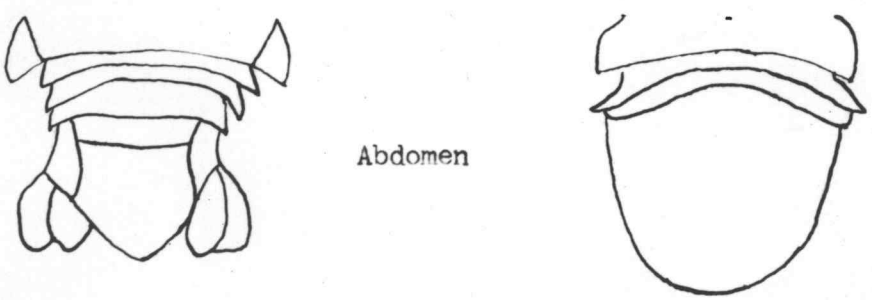
three segments with suture lines showing other partly coalesced segments.

The abdominal appendages are normally well biramous, and consist of a pair of uropods and six pairs of pleopods. The pleopods are branchial and are either equipped for breathing in water or in air. The uropods may be flattened and fold over the pleopods, forming an opercular covering, or form a caudal fan with the terminal segment. They may be terminal and have the general appearance of antennae.

Sexual dimorphism is quite common among the isopods especially where they are parasitic. Here the male is very small and not at all like the female in shape.

Typical Isopod Showing Parts





Abdomen

ARTIFICIAL KEY TO THE SPECIES OF ISOPODS OF THE COOS BAY REGION

1. First pair of legs cheliform. Uropoda terminal
   Leptochelia dubia. *(16)

1. First pair of legs not cheliform. Uropoda lateral or terminal. 2

2. Uropoda lateral. 3

2. Uropoda terminal 20

3. Uropoda and terminal segments forming a caudal fan 4

3. Uropoda folding over pleopods. 13

4. Uropoda with both branches well developed. 5

4. Uropoda with one branch lacking or rudimentary
   Animal living in pilings or submerged wood.
   Limnoria lignorum (20)

5. Isopod not parasitic 6

5. Isopod parasitic on ling cod *Livoreca vulgaris*. . (19)

6. Body contractile into a perfect ball; abdomen composed of two segments 7

6. Body not contractile into a ball abdomen composed of six segments. 10

7. Terminal segment of abdomen entire 8

7. Terminal segment of abdomen with median notch. . . 11

8. Terminal segment of abdomen produced in a rhomboid process *Exospharoma rhomburum* (20)

*Numbers in parentheses ( ) refer to pages on which descriptions may be found.

8. Terminal segment of abdomen not produced in a rhomboid process 9

9. Outer branch of uropoda smooth on exterior margin *Exosphanrom oregonensis* (21)

10. Yellow in color, with scattered black dots. First antennae almost as long as second. . . . . *Cirolana linguifrons* (17)

10. Body dark grey in color. First antennae reaching to the end of the peduncle of the second antennae . . . . . *Cirolana harfordi* (18)

11. Surface of the abdomen smooth *Dynamene glabra* (23)

11. Surface of the abdomen with tubercles or ridges 12

12. Surface of abdomen with tubercles *Dynamene angulata* (23)

12. Surface of abdomen with ridges *Dynamene dilatata* (24)

13. Abdomen consisting of three segments with lateral lines showing another partly coalesced segment . 14

13. Abdomen consisting of one segment with lateral line showing another partly coalesced segment 19

14. Palp of maxillipeds with four articles 15

14. Palp of maxillipeds with five articles 17

15. Body oblong-ovate. . . . . *Idothea ochotensis* (27)

15. Body slender, linear 16

16. Terminal segment with lateral angles obtuse; and middle portion produced in a small point. . . . . *Idothea urotoma* (25)

16. Terminal segment with lateral angles acute and middle portion acutely produced in a point

Idothea fewkesi (26)

17. Terminal segment of abdomen with post-lateral parts more or less angular, and with a distinct acute median tooth 18

17. Terminal segment of abdomen broadly rounded at its posterior extremity, with a small obtuse median tooth . . . . . *Pentidotea wosnesenskii* (28)

18. Sides of thorax parallel. Epimera of segments two to seven occupy entire margin

Pentidotea whitei (29)

18. Sides of thorax arched, somewhat ovate in shape.

18. First three epimera do not reach the entire width of the segments. . . . . .*Pentidotea stenops* (29)

19. Terminal segment of abdomen notched at its extremity. Lateral parts of head produced horn-like. . . . . *Synidotea ritteri* (31)

19. Body oval in shape. Animals found only on spines of purple sea urchin . . . . . *Colidotea rostrata* (32)

20. Free living forms. 21

20. Parasitic forms. Found in branchial cavity of shrimp. Nigricauda *Argeia pugettensis* (34)

21. More or less terrestrial forms. Pleopods fitted for air breathing. 23

21. Aquatic forms. Pleopods not fitted for air breathing 22

22. Fresh water forms. Margin of body fringed with hairs . . . . . Asellus attenuatus (33)

22. Marine form. First, fifth, and sixth thoracic segments white. Others brown Jaeropsis lobata (34)

23. Front of head produced in tubercles; lateral tubercles having horn-like appearance. Dug from the sand . . . . . Alloniscus perconvexus (36)

23. Body depressed, flattened, oblong ovate. Animals not found where they cannot escape from flooding at high tide 24

24. Found on rock cliffs along the coast. Branches of uropoda of about equal length. 25

24. Found under boards, stones, or other objects. . Not at all marine. Surface of body covered with tubercles.. . . . . Porcellio scaber (37)

25. Adult males with epimera broadly expanded; eyes separated by distance equal to twice the length of one eye; basal article of uropoda as broad as long. . . . . Ligia pallasii (39)

25. Epimera not expanded; eyes separated by distance equal to length of one eye. Basal article of uropoda longer than broad . . Ligia occidantalis (38)

DESCRIPTIONS OF THE SPECIES OF ISOPODS FOUND IN THE COOS BAY REGION

Tribe. Tanoidea (Chelifera)

Leptochelia dubia (Krøyer)

Locality. Found in the trash on light-house beach.

Length. 3.5 to 4.5 mm; body elongate

Head narrowed anteriorly, with a blunt process between the antennae. Eyes situated antero-laterally.

First antenna slightly shorter than the cephalothorax. A slender spine is about the middle of the basal article. The second antenna has four articles.

The first free thoracic segment short, second and third equal and longer, fourth and fifth equal and the longest, the sixth is the same length as first.

First five segments of abdomen equal. The sixth is longer and rounded posteriorly, with a blunt projection between the uropods.

The uropod is biramous and longer than the terminal segment of the abdomen. Outer branch composed of one article, the inner of five articles.

The first pair of legs are chelate, other six pairs are ambulatory.

Tribe. Cymothoidea Flabellifera

Cirolana linguifrons (Richardson)

Locality. Dug at mean tide mark from sandy shore. Along open ocean and along parts of Coos Bay.

Body elongate-ovate about five times longer than broad.

Head with frontal margin produced in a long, straight process.

Eyes large.

First pair of antennae with the articles of the peduncle large; flagellum extends to posterior margin of the third thoracic segments. Second pair of antennae extend to posterior margin of fifth thoracic segment.

First three segments of thorax short; other four long. The epimera of the second, third, and fourth segments not produced at apex; those of other segments produced slightly.

Abdominal segments conspicuous, first five of equal length. Fifth segment is wide as the fourth, and lateral parts not covered by post-lateral angles of the preceding segments. The terminal segment is rounded posteriorly, crenulate, and fringed with long hairs.

Uropoda extend beyond tip of abdomen; outer branch more rounded than inner; both fringed with long hairs.

Prehensile legs short; ambulatory legs long and slender. Length of the legs increases gradually from first to seventh pair.

Cirolana harfordi (Lockington)

Locality. Under rocks and mussel beds on rocky shores. One of the most abundant.

Body oblong-ovate, a little more than twice as long as wide. Maximum length 17 mm.

Head wider than long with anterior margin widely rounded. Eyes small and situated at antero-lateral angles of head.

First antennae extend to peduncle of second antennae. Second antennae extend to posterior margin of fifth thoracic segment.

First segment of thorax twice as long as any other. Epimera distinct on all segments except first. Those of last two have outer post-lateral angle produced beyond posterior margins of segments.

First two segments of abdomen entirely concealed by seventh thoracic segment. Terminal segment with apex rounded and furnished with eighteen spines close together.

Inner branch of uropoda is as long as terminal segment of body. Posterior margin and distal end armed with spines. Outer branch almost as long as inner branch, narrower, and rounded, margins armed with spines.

First three pairs of legs prehensile, last four ambulatory.

Livoreca vulgaris Stimpson

Locality. Shores near mouth of Coos Bay. Parasitic in gills of ling cod, Ophiodon elongatus.

Body ovate 18 mm. : 32 mm. Widest at fourth thoracic segment.

Head is triangle, and at the base is wider than long; partly set in first thoracic segment. Eyes are small, situated in the post-lateral angles of the head.

First pair of antennae extends to end of sixth article of second antennae. Second pair of antennae extends to middle of first thoracic segment.

First and fourth segment of thorax longest, about 3 mm. Second and sixth 2 mm. Third and fifth equal 2.5 mm. Seventh is the shortest. Epimera distinctly separate on last six segments.

Abdomen is not narrower than the last thoracic segments. First segment is covered on sides by last thoracic segment. Terminal segment twice as wide as long; widely rounded posteriorly.

Uropoda as long as terminal segment. Both branches alike, rounded at posterior end.

Legs prehensile and furnished with hooks.

Limnoria lignorum (Rathke)

Locality. In submerged timbers near the mouth of Coos Bay.

Body oblong-ovate twice as long as wide 3 to 4 mm in length, covered with long hairs.

Head wider than long. Anterior margin rounded. Eyes in lateral margins of head.

First antennae has a peduncle of three articles and a flagellum of two articles. Last article sometimes absent. Second antennae has first article large. Flagellum composed of two or three indistinctly defined articles.

First thoracic segment larger than rest. Epimera present on all but the first segment.

The abdomen is composed of six segments. The last segment is rounded posteriorly.

Uropoda is lateral. Consisting of an almost obsolete outer branch and an inner branch which is the length of the last segment.

All legs ambulatory.

Exosphaeroma rhomburum (Richardson)

Locality. No data as to locality. Only one specimen was available, and it was in a collection that had been made.

Head small.

First pair of antennae reach almost to posterior margin of first thoracic segment. Second pair slightly longer. Eyes situated post-laterally.

Thoracic segments equal in length. Epimera broad and short, forming an angle with the segments.

First thoracic segment having two tubercles on it, one on either side of the median line. The extremity of the terminal segment is produced in a rhomboidal shaped process. At base of segment are two tubercles, which are continuous with two longitudinal ridges in the center. These ridges unite and continue as one median ridge.

The uropods are shorter than the terminal segment; both branches being equal in length.

Exosphaeroma oregonensis (Dana)

Locality. Under rocks that are covered by the tide.

Maximum length about 1 cm.

Head more than twice as broad as long, with a small process in the center of the anterior margin, bordered on either side by a slight excavation. Eyes small, in the postlateral angles of the head.

The first antennae have the basal article large, and extend to the posterior margin of the head. The second antennae have the basal article short, and extends to the posterior margin of the second thoracic segment.

The first segment of the thorax is longer than any of the others, the lateral margins terminating acutely. Epimera on all thoracic segments.

The anterior segment of the abdomen consists of three partially fused segments. The posterior one is rounded at its free end. Outer branches of the uropoda are shorter than inner ones.

The legs are all ambulatory.

Exosphaeroma crenulatum Richardson

Locality. Living on Pterisophonia woodii on light-house beach.

Body rounded posteriorly and having a square appearance anteriorly. Length 6 mm.

Head rounded in front with a small median point, at either side of which is a small excavation.

First pair of antennae with first joint of peduncle long, flagellum reaches to post-lateral margin of the head. Second pair extend to middle of the first thoracic segment.

Thorax segments about equal. Lateral margins straight. Epimera not distinctly separated from the segments.

First abdominal segment longer than any thoracic segment, with two suture lines. Terminal segment convex, posterior margin rounded.

Uropoda not extending beyond tip of terminal segment. Outer branch widely rounded, crenulate, on the posterior margin.

Legs all ambulatory.

Dynamene glabra Richardson

Locality. Among algae on rocky shores south of the entrance to Coos Bay.

Body oval. Maximum length 5.5 mm.

Head small, eyes situated post-laterally.

First pair of antennae extending to the eye. Second pair extending to the posterior margin of the first thoracic segment.

First thoracic segment is a little longer than the others. Others about equal.

The second from the last abdominal segment has several suture lines. The terminal segment is triangular with a small median notch at its extremity. Surface smooth.

The uropoda with inner branch, large and rounded; outer branch small but similar in shape.

Legs all ambulatory.

Dynamene angulata Richardson

Locality. Found on the rocky shores among the algae, usually Spongomorpha.

Body oval. Maximum length 3.5 mm.

Head large, with median point at its anterior margin.

First pair of antennae reach the posterior margin of the second thoracic segment.

The thoracic segments about equal in length, the first being slightly longer than others. The epimera are broad and short, with acute lateral angles.

First abdominal segment has sutures. It also has three small tubercles in a transverse row, one median and one on either side. The terminal segment is triangular in shape with the extremity produced and deeply notched. At the base are three tubercles in a transverse row, median one longer than others.

Branches of the uropoda are similar in shape, the outer one being longer. Their outer posterior angles are acutely produced. They do not quite reach the tip of the abdomen.

Legs are all ambulatory.

Dynamene dilatata Richardson

Locality. The specimens were collected before the present study was started, and there were no data given as to the locality.

Body oval. Maximum length 8 cm.

Head having a wrinkled appearance, anterior margin produced in a small median projection.

First pair of antennae extend to the posterior margin of the head. Second pair slightly longer than the first.

The thoracic segments equal in length. Epimera almost square, having straight lateral margins.

Abdomen made up of two segments, the first having suture lines, and the terminal segment being triangular with a small rounded notch in the apex. There are three longitudinal ridges on the segment, one of the middle, and one on either side.

The uropoda are short and rounded, not reaching the end of the abdomen. Outer branch smaller than inner branch.

First two pairs of legs covered with hairs and in an anterior direction. The last five pairs extending in a posterior direction.

Tribe. Idotheoidea (Valvifera)

Idothea urotoma Stimpson

Locality. Coast south of Coos Head.

Body linear. Only specimen in collection 12 mm in length.

Head as wide as first segment. Eyes small, round, and located close to the lateral margins.

The first antennae extend to the end of the second article of the peduncle of the second antennae. Second antennae extends to middle of second thoracic segment. Maxillipeds have palps of four articles.

The first segment of the thorax has the antero-lateral angles produced to surround a portion of the head. It is shorter in the middle than any of the six following segments. The epimera of the second, third, and fourth, are narrower plates. The epimera of the last two segments are the only ones that extend the entire length of the segments.

The abdomen is composed of three segments, two short ones and a longer terminal segment, which has suture lines on either side. The terminal segment is more or less quadrangular. The post-lateral angles are prominent, and are separated by a shallow emargination from the triangular middle portion, which is somewhat acutely produced.

Legs all similar and ambulatory.

Idothea fewkesi Richardson

Locality. On floating algae in surf along beach south of Coos Head.

Maximum length 45 mm. Maximum width 7 mm. Body linear in shape.

Head wider than long, slightly hollowed in front. Eyes centrally located on the lateral margins.

First antennae extend to the end of the second article of the peduncle of the second antennae.

The maxilliped has a palp of four articles.

The first thoracic segment is narrower than the rest. Epimera are distinct on all but the first segment. Last four epimera extend entire length of segments.

The abdomen consists of two short and one long terminal segment which has suture lines on it. Posterior segment produced in a blunt tip.

Legs all ambulatory.

Idothea ochentensis Brandt

Locality. One specimen was in the collection that had been made previous to this study. No data were given with it.

Body oblong, with abdomen narrower than the thorax.

Length 1 cm.

Head wider than long. Eyes are small and centrally located on the lateral margins.

First antennae reach almost to the end of the second article of the peduncle of the second antennae. The second antennae reach to middle of the third thoracic segment.

The maxillipeds have palps of four articles.

First thoracic segment is wider than, and partly surrounds the head. All of the segments are equal in length. Epimera on all but the first segment. Those of last two extend the entire length of the segments, and are broader at the posterior end than at the anterior end.

The abdomen consists of two short and one long terminal segment which carries suture lines. The terminal segment tapers part way, and then the sides extend parallel until it begins to round at the post-lateral angles. The median part is produced in a triangular tooth with a slightly rounded point.

Legs alike and ambulatory.

Pentidotea wosnesenskii (Brandt)

Locality. Among algae which are attached to rocks and piling along the Oregon Coast.

Length up to 4 cm. Width to 12 cm. Body more or less linear.

Usually takes the color of the algae with which it is associated.

Anterior part of head narrower than posterior part. Slightly hollowed out in front. Eyes small and situated about middle of lateral line.

First antennae extend to about middle of third article of the peduncle of the second antennae. Second antennae

extend to posterior margin of first thoracic segment.

Maxilliped has a palp of five articles.

Thoracic segments are nearly all equal in length. Epimera occupy the complete margins of the last three segments, and otherwise just a part of the margins.

Of the three abdominal segments, the first two are small, the large terminal segment has suture lines, and terminates in a small, median, blunt point.

The legs are alike and ambulatory. In males the joints are covered with coarse hairs.

Pentidotea whitei (Stimpson)

Locality. The only specimens in the collection were found among coralline algae at Haystack Rock in Tillamook County, and sent to me by M. S. Doty.

Body narrow, almost linear. Longest specimen 29 mm.

Head wider than long with front margin almost straight. First antennae extend to about the second article of the peduncle of the second pair of antennae. Second antennae extend to posterior margin of third thoracic segment.

Maxilliped has palp of five articles.

Segments of thorax equal in length. Epimera of second to seventh extends entire length of segment. Those of last three triangular in shape, with widest part at posterior end of segment.

Of the three abdominal segments, the first two are small, the large terminal segment has suture lines, and terminates in a median point somewhat larger than P. wosnesenskii.

Legs alike and ambulatory.

Pentidotea stenops (Benedict)

Locality. Among algae along coast line from Coos Head southward to Cape Arago.

Body oblong-ovate.

Head wider than long. Anterior margins concave. Eyes are wider than long and situated about the middle of the lateral margins. The first pair of antennae extend to the end of the second article of the peduncle of the second pair. The second antennae extend to the posterior margin of the second thoracic segment.

The maxillipeds have palps consisting of five articles.

First segment of thorax partly encirlces posterior part of head. The segments are not quite equal in length, the second, third, and fourth, being the longest. The epimera extend the full length of the segments except the first three. There is none on the first, while the epimera extend nearly the full length of the second and third.

The abdomen consists of three segments, two short ones, and a long terminal one which shows suture lines. Abdomen somewhat narrower than thorax and sides nearly parallel. The post-lateral angles are rounded and the post-median part is produced in a blunt point.

The legs are ambulatory and similar.

Synidotea ritteri (Richardson)

Locality. Among rocks near coast guard station at Coos Head.

Body ovate. 13 mm. in length.

Head with prominent rounded projections and antero-lateral parts, having a horn-like appearance. There is a median notch in the anterior margin, on each side of which is a prominent tubercle. Between the eyes are two smaller tubercles. The eyes are situated on the lateral margins near the posterior end. The first antennae reach to the middle of the third article of the peduncle of the second antennae. The second antennae extend to the middle of the second segment of the thorax.

The second thoracic segment is the longest, the rest each becoming slightly shorter than the one preceding. Epimera on all segments are extending the full length.

Abdomen consists of one segment carrying suture marks. It tapers to a broadly rounded extremity with a wide shallow

notch in the median part.

Legs alike and ambulatory.

Colidotea rostrata (Benedict)

Locality. On spines of sea urchin Strongelocentrotus purpuratus on rocky shores south of Coos Bay.

Richardson (1905) gives the size up to 12 mm. in length, but those taken at Coos Head did not exceed 2 mm. in length.

Head wider than long produced in front in a short rounded rostrum. Eyes are small and situated on the lateral margins of the head. First pair of antennae extend to the second article of the peduncle of the second antennae. Second antennae extend to the posterior margin of the second thoracic segment.

First thoracic segment partly surrounds the head. The other segments are not quite equal in length, the third, fourth, and fifth being the longest. Epimera are found on only the last three segments and on these they extend only part of the length.

The abdomen is composed of one segment with a suture line. It is rounded posteriorly.

Legs are similar and ambulatory.

Tribe. Asseloidea (Asellota)

Asellus attenuatus Richardson

Locality. In fresh water ditch above and back of the Coast Guard station at Coos Head.

Body narrowed anteriorly, and tapering, gradually increasing in width posteriorly.

Length 8 mm.

Head narrower than thorax, with front margin concave. Eyes located on lateral margins.

First pair of antennae as long as the peduncles of the second pair. Second pair of antennae as long as the body.

Thoracic segments all about of equal length except the last which is longer. Epimera are conspicuous on the last three segments, and inconspicuous or absolete on the others.

The abdomen consists of one segment which is almost as broad as long, and has a median rounded tooth on the posterior margin.

The uropoda are slightly longer than the terminal segment, slender, and with the two branches nearly equal in length and longer than the peduncle.

The legs are slender, long, and armed with spines. All are ambulatory.

Jaeropsis lobata Richardson

Locality. Found in algae on rocky shore near Squaw Island south of Coos Bay. Only two specimens found.

Body ovate-oblong in shape. 3mm in length. The color seems to be striped because the head is brown, the first thoracic segment white, the second, third, and fourth are brown, the fifth and sixth white, and the seventh segment and the abdomen brown.

Head large. Front produced in two triangular processes, brown in color, between which is a large white lobe extending in front of other parts of the head, anteriolateral angles are acutely produced.

Eyes small, situated on lateral margins of head. First pair of antennae very small, equal in length to the width of the head.

Thoracic segments about equal in length and having the appearance of being separated somewhat from each other.

Abdomen consisting of one segment which is rounded except for two notches where the uropoda are attached. Uropoda very short.

Legs alike and ambulatory.

Tribe. Bopyroidea (Epicaridea)

Argeia pugettensis Dana

Locality. In branchial cavity of the shrimp Crago along the Oregon Coast south of Coos Bay.

Adult female about 10 mm. long, one side rounded more than the other. This is because she has taken the shape of the branchial cavity in which she is living. The side that is the most rounded is dependent upon the cavity in which she lives.

Head a little wider than long and having the appearance of being divided into two lobes. Eyes absent. Antennae, both first and second pair, very small, not visible from dorsal side.

All segments of the thorax are distinct and about the same length. Epimera on all segments. First four segments have ovarian bosses present.

Abdomen consists of six segments which are distinct, the first one being the widest, and each succeeding one being narrower than the one before, making the abdomen V shaped. The uropoda are simple and shorter. The pleopoda are attached to the central side of the abdomen as usual, but extend outward in such a way as to seem to form a border around the abdomen, when seen from the dorsal side.

The legs are all prehensile and used for clinging. Not ambulatory.

The male is oblong and symmetrical in shape, less than 5 mm. long. The head is rounded. The segments of the thorax are distinct. The abdomen is composed of a single segment widely rounded. The legs are all prehensile.

Tribe. Oniscoidea

Alloniscus perconvexus Dana

Locality. Dug at mean tide mark in sandy beach south of Coos Head.

Richardson (1905) also gave Tillamook Head, Oregon, as one of the localities.

Body ovate in shape. Maximum length 9 mm.

Head wider than long with lateral parts in front produced in a triangular process. The front is a widely rounded lobe. Eyes are small and situated at the extreme sides of the head. The first pair of antennae are very small and inconspicuous. The second pair of antennae are covered with small spines, and extend to the posterior margin of the first thoracic segment.

Firt thoracic segment is longer than the rest which are about equal. Epimera extending part of the length on the first four segments, and entire length on last three.

The abdomen is composed of six segments. The lateral parts of the first two are covered by the last thoracic segment. The terminal segment has its posterior margin widely rounded, and the lateral parts covered by the fifth segment.

The uropoda are very short, with the inner branch shorter and more slender than the outer branch.

The legs are ambulatory and covered with hairs.

Porcellio scaber Latreille

Locality. Found under wood and boards at Coos Head. This is probably the most cosmopolitan of all isopods.

Body ovate in shape. Maximum length about 12 mm. covered with small tubercles.

Head wider than long. The anterior margin produced in one median lobe with two additional lobes, one on either side. The first antennae are small and inconscpicuous. The second pair extend past the posterior margin of the second thoracic segment

The segments of the thorax are about equal in length, with no visible indication of epimera.

The abdomen is composed of six segments, the lateral parts of the first two being covered by the last thoracic segment. The terminal segment is produced in a long acute process, with the end somewhat rounded.

The uropoda are longer than the terminal segment, the inner branch being the shorter of the two.

The legs are ambulatory.

Ligia occidentalis (Dana)

Locality. Near salt water tank at Coos Head.

Body oblong-ovate. 12 mm long. Covered with small granules.

Head with anterior margin widely rounded. Eyes large. First pair of antennae small and inconspicuous. Second antennae are long, extending to the posterior margin of the sixth thoracic segment.

The first four segments of the thorax are about equal and are a little longer than the last three which are also about equal. There are no visible epimera.

The abdomen is composed of six segments. The first two have their lateral parts covered by the last thoracic segment, and are shorter than the last three. The terminal segment is produced posteriorly in a triangular point.

The uropoda are long with both branches of equal length. Length of uropoda about 3.5 mm.

The legs are all ambulatory.

Ligia pallasii (Brandt)

Locality. On rocky cliffs along the coast south of Coos Head. In cracks of piling.

Body oblong-ovate; maximum length about 30 mm. Surface covered with very small granules or tubercles.

Head much wider than long. Anterior margin rounded. Eyes large occupying much of the lateral margins of head. First antennae small and inconspicuous. The second antennae long, extending to about the middle of the fourth thoracic segment.

First four segments of thorax about equal in length, and somewhat longer than the last three segments which are also about equal. Epimera are conspicuous on the last six segments. They extend the full length and are much wider on males than on females. This difference between the sexes causes the adult males to look much broader and rounder than the females.

The abdomen consists of six segments, the lateral parts of the first and second, and a portion of the third being covered by the seventh thoracic segment. The lateral parts of the third, fourth, and fifth segments are produced posteriorly, the fifth seeming to surround the sides of the terminal segment part way. The terminal segment is rounded

posteriorly, with the lateral angles produced not quite as far as the median portion.

The peduncle of the uropod is short and the branches are equal in length and about twice as long as the peduncle.

The legs are ambulatory.

ECOLOGY OF THE COOS BAY ISOPODS

The shore line south of Coos Head can be divided into a number of typical environmental communities. The sand beach, while not inhabited by as many forms as is the rocky beach, is a dwelling place of a number of animals among which are found several species of isopods. Alloniscus perconvexus Dana is one of the sand dwelling forms which was dug at mean-tide in a sand beach along the south shore of Coos Bay a short distance east of the Coast Guard station.

Another species, Cirolana linguifrons Richardson, was found in this same sand beach. But unlike Alloniscus perconvexus, it was also found in the sand beaches along the open ocean. Large numbers may often be seen swimming in tide pools in depressions in the sand during the time of an outgoing tide. If disturbed they hurriedly bury themselves in the sand. As soon as the disturbance is over they then immerge and start swimming again. A large number of them were once found feeding on the fragments of

a dead unidentified jelly-fish washed up on the beach.

There are a number of isopods, especially those belonging to the genus Idothea which, while they are not sand dwelling, are sometimes found on the sand or floating in the surf clinging to bits of algae. The most numerous of these was Idothea fewkesi Richardson which often could be found on almost any piece of algae floating in the surf. They could not be considered abundant for only one or two specimens could be found on each fragment of algae. This species seems to be closely associated with algae wherever it is found, either in the surf or on the rocks that are exposed to low tide. The only locality given by Richardson (1905) for this species, is Santa Barbara, California, and I have not found it referred to in other literature.

Only one specimen of Idothea ochotensis Brandt was found, and it was a part of the collection already at the Oregon Institute of Marine Biology before the present study was started. Unfortunately no data were given by the collector, so no definite statements can be made as to where it was found. Since it was in a bottle with some specimens that were found among algae, it is possible that it lives under conditions similar to those of I. fewkesi.

Still another species in this genus which is found here is I. urotoma Stimpson. Again it is unfortunate that

there were few data left by the collector as the only specimen was in the collection along with I. ochotensis. It is evident that both of these species are not plentiful in the waters along the Oregon Coast.

Among the first specimens collected for this study was Leptochelia savignyi Krøyer a member of the subclass Chelifera. Through accident these tiny isopods, 1 mm. to 2 mm. in length, were lost. The following summer none could be found though a constant search was made for them. Richardson (1905) lists this species as an Atlantic form and I would hesitate, without further proof, to include it here. However Fee (1927) reports finding two members of the same genus L. filum Stimpson L. dubia Krøyer at Departure Bay in Canada, that had not been previously recorded from the Pacific Coast. Richardson (1905) describes L. dubia as fitting the description of L. savignyi in every respect except that there are five articles in the uropoda of the former and six in the uropoda of the latter. It is quite probable that the specimens found at Coos Head were L. dubia instead of L. savignyi, and that the first specific identification was not correct.

This species was inhabiting the trash washed up on the beach of the open ocean, not a very permanent dwelling place.

Another habitat in which isopods are found is the rock cliffs; the highest parts of which are wet only by spray

from the breakers, and the lowest part being only a few feet above the low tide line. The only species living here, and that in great numbers, is Ligia pallasii, Brandt. It is one of the most common and largest of the isopods, and as a result probably has been the subject of more studies than any other species found on the west coast. A number of these studies will be referred to in the following paragraphs. According to Johnson and Snook (1935) this species is northern and is replaced in the south by L. occidentalis Dana. Abbott (1940) notes that the two are ecologically very similar except that L. pallasii has a longer survival in dry air and a shorter survival in sea water. He also states that the family Ligydidae is "almost exactly midway between aquatic and land animals." Miller (1938) calls attention to the sexual dimorphism in the body proportions of L. pallasii. The males are broad because of their laterally expanded epimera. Young males are about intermediate between adult males and females and reach their broader proportions after a few molts. The adult males seem to make use of their size by forming protective shields over the females and young males. The females, because of their smaller size, are able to move deeper into the cracks than the males, and find protection that they otherwise would not have.

L. pallasii cannot be considered truly terrestrial (Abbott 1940) because of the breathing apparatus. In the truly land forms the exopodites of part or all of the pleopods contains numerous branching tracheae which act as the breathing tubes. L. pallasii does not have these tracheae, but instead holds a film of water with its outer branches of the pleopods held over the inner branches and close to the abdomen. If one holds an isopod in his hand, he can see this water and also see waves passing over it as the animal breathes. When the animal is in the water, the pleopods are held extended away from the abdomen and are constantly waved about. When it approaches a tide pool, it tests the water with its antennae and then turns around, coming to rest with the tip of its abdomen in the water.

From the observations mentioned above, it would seem possible that Ligia belongs to a group of animals that are in a transitory stage of migration from an aquatic to a terrestrial existence. Such a statement of course, is rather speculative, but the previous quotation from Abbott that they are almost midway between the two, and the findings of Barnes (1938) that they, if given a choice of filter paper soaked in distilled water, would indicate that one has grounds for calling them a transitory animal. A member of the genus Ligia must have a film of moisture on its pleopods

in order to utilize oxygen from the air, and yet when placed in water, it is very much less active than it is on land.

The members of L. pallasii are never closely associated with algae, but are quite often found living on exposed portions of piling, hiding in cracks or under bark.

One specimen of Ligia that was collected at Coos Head closely resembled the description of L. occidentalis. In fact it fits the description in every detail, but I hesitate to call it that because this species is always found in great numbers, never singly (Rickets, and Calvin 1939). It was an immature specimen, however, and may be a variant of L. pallasii.

On rocky shores protected from heavy wave action by off-shore points of rock or in some other way, are the habitats of several species of isopods. Possibly the most abundant of these is Exosphaeroma oregonensis Dana. Richardson (1905) lists a large number of localities in which they have been collected, and states that in one instance they were living in fresh water, and in some cases were buried in the mud or sand. During the study at Coos Head they were found only under rocks that are covered with water at high tide. They were found along the protected beaches of the bay as well as along the beaches of the open ocean. This same species has been collected along the

Oregon coast at Roads End, Boiler Bay, and Yaquina Head showing that it has a rather wide distribution.

Abbott (1940) states that the details of the behavior of E. oregonensis have not been investigated, but he also says that the family Sphaeromidae, of which this species is a member, is in the process of conquering a variety of habitats, with its greatest success in becoming adapted to fresh water.

This isopod is a member of a group of related genera that are commonly called "pill bugs," because of their ability to roll themselves into a ball when disturbed. They are slow moving when on land, and have a rather short survival period when not in the water. One finds them by turning over rocks that are covered by high tide. Here they live in considerable numbers usually in small depressions under the rocks in which a little water has been left by the outgoing tide. On warm days during low tide this water may often become several degrees warmer than that of the ocean. They are quite active and seem well adapted to this temporary habitat, (Abbott 1940). While collecting Limnoria in the pilings, many specimens E. oregonensis were found, but they were very small in size. They seemed to be living in the old burrows made by Limnoria, but otherwise the two species apparently were not associated.

Fee (1926) notes that E. oregonensis is sometimes mistaken for one that is destructive to pilings. This is probably due to their small size and the association with Limnoria. Sphaeroma pentadon Richardson, a form found further south is often mistaken for E. oregonensis but has not been recorded this far north. Fee (1926) states that it was not found at Departure Bay "although a constant search was made for it."

A single specimen of Exosphaeroma rhomburum Richardson was in a collection made by Max Doty of the Oregon Institute of Marine Biology before the present study was undertaken. No data were given with it so it is impossible to include it from an ecological standpoint. The only locality given by Richardson (1905) for this species is Monterey Bay.

Three species of the genus Dynamene are found along the Oregon Coast, at least in the Coos Bay region. This genus also belongs to the family Sphaeromidae so with Exosphaeroma, is among those animals generally called "pill bugs." Dynamene angulata Richardson is found on the rocky shores that are not exposed to heavy wave action. But unlike Exosphaeroma which is found here also, it is closely associated with an algae, which, at Coos Head, as far as was observed was always Spongomorpha. It is a very small species and can hide well in the fronds of this plant.

A secodd of these three species was D. glabra Richardson which in every case was found among the algae. However it was observed with several species, so it is probable that this animal is not closely associated with one genus of algae as was D. angulata.

The third of these three species is D. dilatata Richardson. Like some of the other isopods these had been collected prior to the time the present study was started, and no data were given. The only locality given by Richardson (1905) is Monterey Bay, California.

Pentidotea wosnesenskii Brandt is another common species found either associated with algae or among the mussels or rocks exposed to low tide. Richardson (1905) gives numerous localities from which specimens have been secured along the west coast of North America, but makes no reference to any having been found in Oregon. Very little literature is available for this species, indicating that little investigation has been carried on concerning the habits, life history, and ecological relationships. It is a truly marine animal, having the pleopods equipped for breathing in water only, and consequently is found as deep as nine fathoms (Richardson 1905). It is of no apparent economic importance so has not been included in studies that have been made.

In addition to being found on the rocks at low tide numerous specimens were found on the floating wharf at Charleston on Coos Bay. It was noted that the members of this species usually take the color of the algae or material to which they cling. Among the Ulva growing on the floating wharf the P. wosnesenskii found were invariably green. Those on the rocks among the Ulva were also green, while those found on the various Phaeophyceae or Rhodophyceae were nearly always dark brown.

Besides being abundant in the Coos Bay region this species is rather common on almost any part of the Oregon Coast. Specimens were taken at Roads End, Boiler Bay, Otter Rock, and Yaquina Head.

Another species of the same genus is P. stenops Benedict which is also found in the Coos Bay region. It is not as common as P. wosnesenskii, but is also found among the algae. Richardson gives the only locality as Monterey Bay, California. No specimens were found among the Chlorophyceae so there is no direct evidence that it has the ability to change color to suit its surroundings. Since the specimens that were found were dark brown in color, and were found in algae of that color, it is possible they may have this characteristic just as P. wosnesenskii.

Synidotea ritteri Richardson, is a species belonging to the same family as Pentidotea. It is found also among

the algae on the rocks exposed at low tide. These animals are not very plentiful, in fact were only found during this study on the rocks near the Coast Guard station. There were a few in the collection that had been made previous to this study, but no data were given as to the habitat in which they were found.

Two specimens of the species Jaeropsis lobata Richardson were found among the algae at the outer reef of Squaw Island, a rocky point south of the Cape Arago Light house. Richardson (1905) in describing it mentions the peculiar color markings which cause it to appear striped. This fact is noteworthy in that the descriptions of very few isopods include remarks about the color. Because of the scarcity of specimens practically nothing is known about its ecological relationships.

Cirolana harfordi Lockington is one of the most abundant species found on the Oregon Coast. Adults are seldom if ever found associated with algae, but rather live under rocks or in beds of the common mussel, Mytilus californianus Conard. Immature specimens may often be found in algae that have washed up on the beach. When found under the rocks, they may be near the high tide line or lower, but M. californianus is an inhabitant of the rocks that are subjected to heavy wave action and are usually near the low tide mark.

Because of this fact C. harfordi when found near low tide line is well protected from the pounding of the waves under several layers of mussels.

As has been mentioned for several of the other common species, it is rather strange that very little published material is available regarding C. harfordi. While they are numerous enough to be available in large numbers for study, they are of very little economic importance. This together with the fact that they are not commonly seen except when being hunted, probably accounts for the lack of investigation.

Colidotea rostrata Benedict is a species of isopod found only on the purple sea urchin, Strongylocentrotus purpuratus Stimpson (Ricketts and Calvin 1939). There were not many on each sea urchin but one could always find two or three. According to the description by Richardson (1905) they should reach a length of 12 mm. but the specimens found during this study were not over 3 mm. long.

Isopods belonging to the genus Limnoria have been the subject of considerable study because of the damage they do to the pilings. For this reason, and because of other marine borers, a special committee was appointed on July 22, 1920, by the American Wood Preserver's Association to study the marine piling problem in San Francisco Bay. The

size of the committee was later increased and the work expanded. The final report was published in book form in 1927. In the final report a Biological Section was included by C. A. Kofoid and R. C. Miller in which a great deal of information was given about Limnoria some of which is included in the following paragraphs.

Limnoria lignorum Rathke, the species found in the pilings in Coos Bay near the Oregon Institute of Marine Biology station, is world wide in distribution. It has probably been introduced into new areas by ballast water from ships and by floating pieces of driftwood. The young are unable to swim when they first leave the brood pouch and acquire the habit only after they grow older. In waters that maintain a fairly even temperature they breed throughout the year. At Beaufort S. C. it has been found that there is a definite breeding season and that it is correlated with the temperature. In that locality 14°C is a critical temperature below which breeding ceases (Kofoid 1927). It was noted that this was not a critical factor at San Francisco Bay.

Examination of the stomach contents shows that L. lignorum live on a diet of wood, and because of its low nutritional value, they must eat continuously. They rarely burrow in more than a half inch but work along parallel with the surface, and as they work pieces of wood are cut

free from the piling and float away. Thus, the piling is reduced in size until it finally gives way altogether. Investigations by Kofoid (1927) show that salinity as low as 6.5 parts per 1000 of water is lethal in twenty-four hours, while salinities of 12, 14, or 16 parts per thousand cause a decided retardation in the activity of the animals. They are found only where the salinity concentration of the water is fairly high, or where low concentrations are quite temporary.

L. lignorum are found in "marine timbers" along the Oregon Coast, and during the study at Coos Head were found in abundance in untreated piling in Coos Bay near the Oregon Institute of Marine Biology. In pilings that had been treated and not subsequently damaged, there was no sign of an attack by these animals, but if the treated part had become broken or cracked so that the borers could get a start in the wood beneath the treated layer there might be nothing left but the treated shell of the pilings. Part of this damage may have been due to other borers, but in this particular area there were no others as numerous as L. lignorum.

Two species of parasitic isopods were found during this investigation. One of these, Argeia pugettensis Dana has already been mentioned as living in the branchial

cavity of the shrimp Crago nigricauda Stimpson. This parasite shows an interesting sexual dimorphism. The male is symmetrical in shape and is smaller in size than the female. Unlike the female it has limited powers of locomotion. The female is asymmetrical taking the shape of the branchial cavity in which it is found. If it is in the left branchial cavity, the body has its longer side on the right and shorter side on the left. If it is in the right branchial cavity, the shape of the body is just the opposite.

All of the shrimps that were collected during the summers of 1940 and 1941 were examined and no case of bilateral infection was found. Semper (1881) observed that a parasitic isopod in one branchial cavity of a shrimp prevented the entrance of the same species on the opposite side.

Like many parasites the adult female is incapable of locomotion. Her brood pouches are very much enlarged and of the specimens found during this study each contained many hundreds of young. Not only has this species been modified to obtain its food parasitically, but its powers of reproduction have increased to compensate for the precarious life that it leads.

Livoneca vulgaris Stimpson was the other parasitic isopod found and was taken from the gills of a ling cod,

Ophiodon elongatus Girard, which was caught at the mouth of Coos Bay. Only one specimen, a female, was found. It was rather larger than the measurements given by Richardson (1905), being 32 mm. long. Its brood pouch was much larger than the free living forms and was full of young, but the number of young was not nearly as great as in A. pugettensis. The body was symmetrical in shape, and the legs were short and all prehensile being used for grasping rather than for locomotion.

There are two species of isopods found in the Coos Bay region which should be included although they are not marine. One is Porcellio scaber Latreille, and the other is the fresh water species Asellus attenuatus Richardson.

Porcellio scaber is probably the most universally known isopod, and goes under the common name of "sow bug." It is often pictured in textbooks on Zoology as a typical example of the order Isopoda. It is found abundantly in moist places under leaves and boards. A very few specimens were found with Ligia on pilings that supported the old jetty railroad at Coos Head, as well as at numerous places on the shore. It is a terrestrial form, breathing by means of trachea in the exopodites of the first two pair of pleopods. According to Modlinger (Miller 1938) there is another genus of isopods better adapted to life on land, but none with more complex tracheal organs.

Asellus attenuatus, the only fresh water form included in this study, was taken in great numbers from the mud in the bottom of a fresh water ditch back of the Coos Head Coast Guard Station. There seems to be no available literature referring to any studies made of this species.

DISCUSSION AND CONCLUSION

Twenty-four species representing sixteen genera have been listed in the foregoing pages, and as many of the ecological aspects as possible have been recorded. A chart has been included in order to show at a glance the existing relationships. It is difficult in a chart of this kind to include all of the factors that should be considered. The attempt has been made to include all of the species mentioned herein, but it can readily be seen that those living on the spine of the sea urchin, or those parasitic on other forms do not lend themselves to a classification such as has been attempted here.

From this chart is can be seen that there are more species of isopods living on the attached algae than under any other condition. This does not include, however, the total number living there. In the attached algae it may be possible to find only one or two specimens here and there, while under some of the other conditions such as in the mussel beds, one finds many isopods. They can almost

be picked up by the handful. Three of the species have been observed living under more than one condition, i.e. under rocks and under mussels, or under rocks and in pilings. The rest of the species were each collected from only one habitat.

If the isopods are considered as a whole, with the exception of Limnoria, it is very apparent that by far the largest total number of animals are found belonging to very few species. These species may vary from year to year, but on the whole they are members of the genera Exosphaeroma, Cirolana, and Ligia. With but few exceptions, wherever these animals are found they are very plentiful. It is obvious that conclusions drawn from a study of any group of animals in such a limited area would not necessarily hold true in another area, but there are certain conclusions that can be drawn from this study that would be a beginning for a study of the same animals in other areas.

A description of the animals will show that there are certain structural characteristics that are usually found in animals living in certain habitats. In any key to the species the isopods are placed in tribes or superfamilies partly by the position of the uropoda. The uropoda may be either terminal or lateral, and if lateral may either cover the pleopods, not visible from a dorsal view, or may

form with the terminal segment a caudal fan. In general those isopods having terminal uropoda live in a specialized habitat. They are either parasitic or have migrated towards a terrestrial existence. Those with lateral uropoda that form a caudal fan live where they have an occasion at times to swim, quite often in tide pools. The third group, those with lateral uropoda that are folded over the pleopods, are always found crawling over attached algae or clinging to floating algae. No study of the structure of the legs with relation to the habitat in which the animals were living, was made. If such an investigation were undertaken, it is quite possible that it would show a specialization for the various habitats.

During this study two parasitic isopods were collected and have been described herein. The one found in the branchial chamber of the shrimp was necessarily enclosed by the carapace in such a way that it could never get out. Its body parts were deformed and not at all symmetrical. In the brood pouch of the female were thousands of young. The brood pouch was extended until it was larger than the rest of the animal. The structure of the parasitic isopod found in the gills of the ling cod was entirely different. It was evidently in an earlier stage of migration towards a parasitic existence. The body was symmetrical, there were only a fraction as many young in the brood pouch, (this may

have been due to the period in the breeding season when it was collected) and the legs, while they had undergone some change, were still capable of limited locomotion. It would seem from these very limited observations that the more completely parasitic an isopod is, the more young it is necessary to produce in order that the species may survive. It might also be said that the more completely parasitic an isopod is, the more degenerate it becomes in many ways.

It is interesting to note that Ligia pallasii, the species that is possibly in a process of migration to land, is one of the few species found in large numbers. Rickets and Calvin (1939) make the statement that L. occidentalis to the south is only found in large aggregations and never singly. Another species that is found in large numbers is Cirolana harfordi, and the mussel beds in which it lives are out of the water during a low tide period for considerable time. One cannot draw a general conclusion from these facts, but it might be possible that a move towards land life is accompanied by groupings such as have been mentioned. The facts given above might be a starting point for further investigation.

The grouping mentioned in the previous paragraph may or may not be an indication of a migration towards a terrestrial existence, but a study of isopods as a whole definitely indicated that there are many that breathe only

in air as well as those that breathe in water. Mention has already been made concerning the possibility that the genus Ligia is in a transitory state between an aquatic and a terrestrial existence. Studies have shown that it is a member of a group of isopods that have a breathing apparatus that seems to be midway between these two. (Abbott 1940). Humidity-gradient experiments were conducted by Miller (1938) in which it was found that the terrestrial isopods if given a choice, prefer a high humidity. This experiment, together with the fact that terrestrial isopods are found living only in moist habitats under rocks, wood piles, and similar places, would seem to indicate that these animals have recently migrated to land.

This study of the isopods of the Coos Bay region is only a beginning. It has opened up more questions than it has answered. For instance what effect does salinity of the water have on various forms? What happened to Asellus attenuatus when the stream dried up? How many more species visit the shores of Coos Bay that were not included in this study? How many of those included in this study are only visitors and how many permanent inhabitants? These and many other questions might be asked, and each one of them prove an interesting study.

DISTRIBUTION CHART

Column 1 indicates habitat having an abundance of isopods.
Column 2 indicates habitat having a moderate number of isopods.
Column 3 indicates habitat having a small number of isopods.

	Sand Beach			Floating Algae			Attached Algae			Under Rocks			Under Mussels			In Piling			Para-sitic			Other Habitat		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Leptochelia dubia				x																				
Cirolana linguifrons	x																							
Cirolana harfordi								x			x			x										
Livoneca vulgaris																					x			
Limnoria lignorum																	x							
Exosphaeroma rhomburum	no data																							
Exosphaeroma oregonensis											x						x							
Exosphaeroma crenulatum					x																			
Dynamene glabra								x																
Dynamene angulata								x																
Dynamene dilatata	no data																							
Idothea urotoma	no data																							

DISTRIBUTION CHART (Cont'd)

	Sand Beach			Floating Algae			Attached Algae			Under Rocks			Under Mussels			In Piling			Para-sitic			Other Habitat		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Idothea fewdesi				x																				
Idothea ochotensis					x																			
Pentidotea wosnesenskii							x				x			x										
Pentidotea whitei								x																
Pentidotea stenops								x																
Syndotea ritteri								x																
Colidotea rostrata																								x
Asellus attenuatus																							x	
Joeropsis lobata								x																
Argeia pugettensis																				x				
Alloniscus perconvexus	x																							
Porcellio seaber																							x	
Ligia occidentalis																								x
Ligia pallasii																								x

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