The Role of Owl Limpets (*Lottia gigantea*) in Shaping Intertidal Community Structure

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INTRODUCTION

The owl limpet Lottia gigantea is a conspicuous intertidal mollusc at San Nicolas Island, Ventura County, California. These large limpets may exceed 100 mm in length and range from northern California to at least Isla de Guadalupe in Baja California, Mexico. Lottia gigantea is a territorial species and each large limpet maintains a cleared territory of approximately 1000 cm 2 (Stimson 1970, 1973). All most all other invertebrates and algae are removed from these territories and in areas where L. gigantea occurs at high densities the midlittoral regions appear denuded.

Lottia populations have been overexploited by humans from virtually all easily accessible areas. The only remaining natural populations occur on the offshore islands of California and Mexico and in protected and remote habitats along the mainland such as the Big Sur region south of Monterey. Where Lottia does occur the midlittoral communities appear different from midlittoral communities where it is absent. The most noticeable difference is the absence of algae, sessile invertebrates such as mussels and barnacles, and other herbivorous gastropods in those areas in which Lottia is present.

The objective of our study is to determine the role of Lottia gigantea in littoral community structure at San Nicolas Island. Earlier studies (Stimson 1970, 1973) have

demonstrated that Lottia have an important effect on other organisms in and immediately surrounding their territories. Because Lottia populations have been overexploited by humans throughout most of their range, this study will provide some insights into the sorts of recent changes that may have taken place in littoral community structure along much of the Pacific coast of the United States.

METHODS and MATERIALS

We selected four study sites along the southwest coast of San Nicolas Island. Each site was well circumscribed by natural boundries that limit Lottia migration into the study sites. Superficially, these areas all appeared to be similar to one another in terms of their physical and biological makeup; Lottia were abundant in the midlittoral zones, and the distributions and abundances of the other common species there were similar. Each study site was divided into four levels or heights. These heights approximately corresponded to biological zones. Height 1 corresponded to the high littoral barnacle/limpet zone, Height 2 corresponded to the midlittoral Lottia zone, height 3 to the mussel zone, and height 4 to the low littoral coralline algae/Phyllospadix zone. Within each height zone three permanent quadrats were place. The quadrats measure one quarter square meter each and are further divided into 25 subplots and 32 point samples. Percent cover and density of all identifiable plants and animals in each quadrat are

measured at bimonthly intervals. We also photograph each quadrat bimonthly with infrared color film to record changes in encrusting and upright algal cover. It is also possible to obtain sizes of macroinvertebrates from these photographic records. In addition, three permanent transects in each study site were established. These transects extend from above the barnacle/limpet zone to below the coralline/Phyllospadix zone. Plants and animals occurring under the transect lines are recorded at 10 cm intervals along the transect.

Between February, 1980 and June, 1980 the study sites were monitored three times prior to the removal of the Lottia from study sites 1, 2 and 4. All Lottia found in the experimental study sites are removed during each monitoring visit. The data presented here covers the period between February, 1980 and April, 1981.

RESULTS

Figures 1-4 present mean densities (plus and minus standard error) for three species of molluscs and one species of algae within the 4 study sites. At Site 1 (Fig. 1) the removal of Lottia gigantea in June 1980 produced no significant short term changes. However, by December, 1980 trends became readily apparent. The limpet Collisella scabra began a slow yet steady increase in density whereas another limpet Collisella digitalis essentially disappeared from the study site. At study site 1 the green alga Ulva

showed a small recruitment in August, 1980, disappeared in October and then resurged in December.

At study site 2 (Fig. 2) the changes in these three species were much more rapid as well as slightly different from study site 1. By August, 1980, just 2 months after the removal of Lottia, the C. digitalis population had increased by a factor of 10. The C. digitalis population continued to increase until February 1981 when it began decreasing. Collisella scabra also began a rapid increase in density although slower than that seen in C. digitalis. However, by April, 1981 it appears that the combination of the decreasing C. digitalis population with the slowly increasing C. scabra population will result in a numerical dominance of C. scabra over C. digitalis as seen also at study site 1. Ulva at study site 2 also showed a recruitment in August and persisted at the study site through April, 1981.

Study site 3 is the control site and the densities of the three species at this site with Lottia present were much different than at any of the experimental sites (Fig. 3). Ulva was never present at study site 3. Lottia showed little change through time and the population appeared stable. The most interesting changes at the control site were in the densities of C. digitalis and C. scabra. Neither of these species showed population increases like those seen at the experimental sites. Instead there appeared to be a tradeoff in densities between the two

species. Between April, 1980 and October 1981 C. digitalis was numerically dominate In December, 1980 C. scabra was more common and the densities of C. digitalis were substantially decreased. However, this was a short term event and C.digitalis was again dominate through February and April, 1981.

At study site 4 (Fig. 4) the changes were similar to those seen at Site 1 except they were much more rapid. Both C. scabra and C. digitalis showed initial increases in density, however only in C. scabra was this tend sustained. Density of C. digitalis fell to zero by December, 1980. Ulva showed a large recruitment in August, 1980 and again in December.

DISCUSSION

Species that are capable of structuring intertidal systems have been known for approximately 20 years. Paine (1966) in the Pacific northwest has shown the importance of the sea star Pisaster ochraceus in structuring low and midlittoral communities. More recently, Branch in a series of papers (1971, 1975, 1976) has shown the importance of territorial limpets in South Africa in littoral community structure. We believe that Lottia digitata is also an important organism for structuring intertidal communities in California and Baja California, however the drastically reduced densities of this species along the mainland has prevented its recognition until now. Moreover, the absence

of Lottia from much of the coast means that many of the previous studies of rocky intertidal areas have not had this important species present in the system and the results of these studies must be carefully considered. Many of these studies have considered that that lower limits of intertidal invertebrates are set by biological interactions whereas the upper limits are determined by physical factors. However, the presence of Lottia in the midlittoral certainly prevents upward movement and/or recruitment by low littoral and low-midlittoral species. Moreover, because Lottia hads been an important factor in the evolution of many of these invertebrates (as demonstrated by the specific escape responses of many invertebrates to Lottia) its relatively recent removal may have upset and altered rocky intertidal community structure in recent years.

Our results show that Lottia gigantea has a significant effect on the alga Ulva and on two other species of limpets, C. digitalis and C. scabra. Ulva never appeared at our control site with Lottia present however it was abundant at all three experimental sites after the removal of Lottia. Both of the limpet species increased in density after the removal of Lottia however, quite unexpectedly a second interaction between C. scabra and C. digitalis has been found that suggests that C. scabra will ultimately displace C. digitalis from the sites where Lottia is absent. Therefore, it appears that Lottia some how mediates the C. digitalis-C. scabra interaction and allows for both species

to coexist in its presence. Although the C. digitalis-C. scabra interaction has been examined before (Haven 1971, 1973), these studies were done in the absence of Lottia and the results were interpreted in terms of physical factors rather than than biological. This appears to be the first case of facilitation between territorial and nonterritorial limpets.

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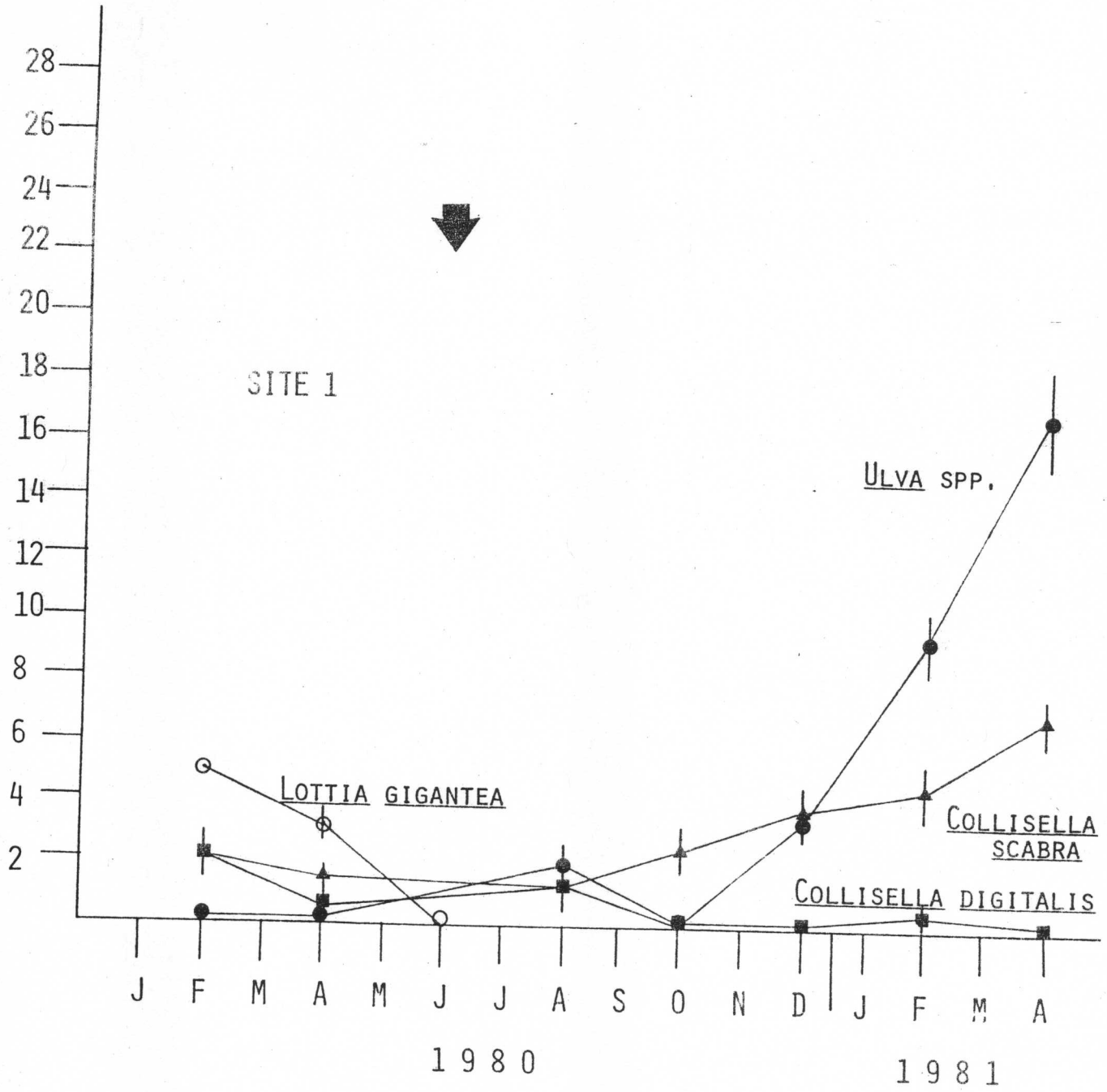
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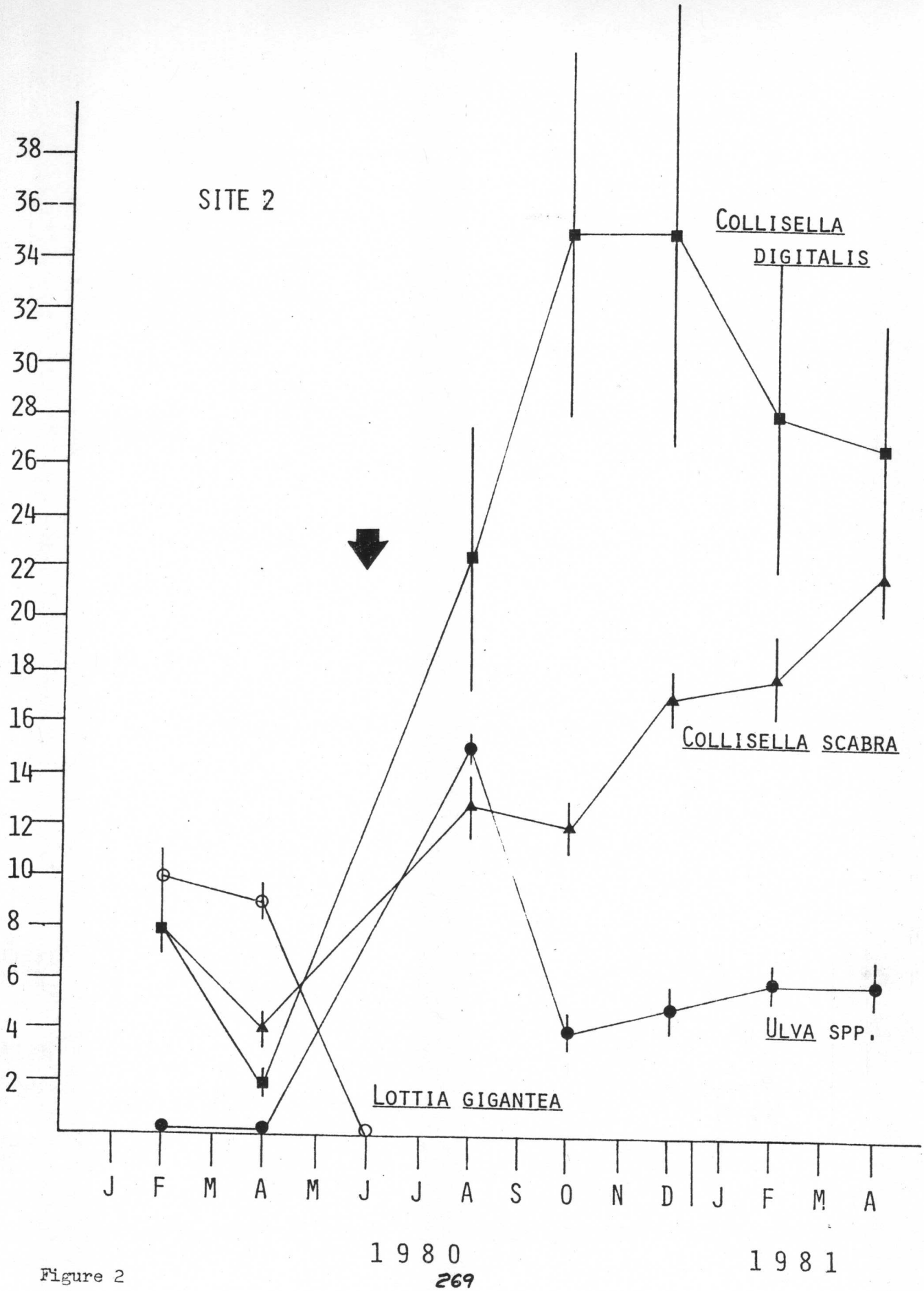
SITE 1
ULVA SPP.
LOTTIA GIGANTEA
COLLISELLA SCABRA
COLLISELLA DIGITALIS
J F M A M J J A S O N D J F M A
1980
1981

Figure 1


SITE 2
COLLISELLA DIGITALIS
COLLISELLA SCABRA
ULVA SPP.
LOTTIA GIGANTEA
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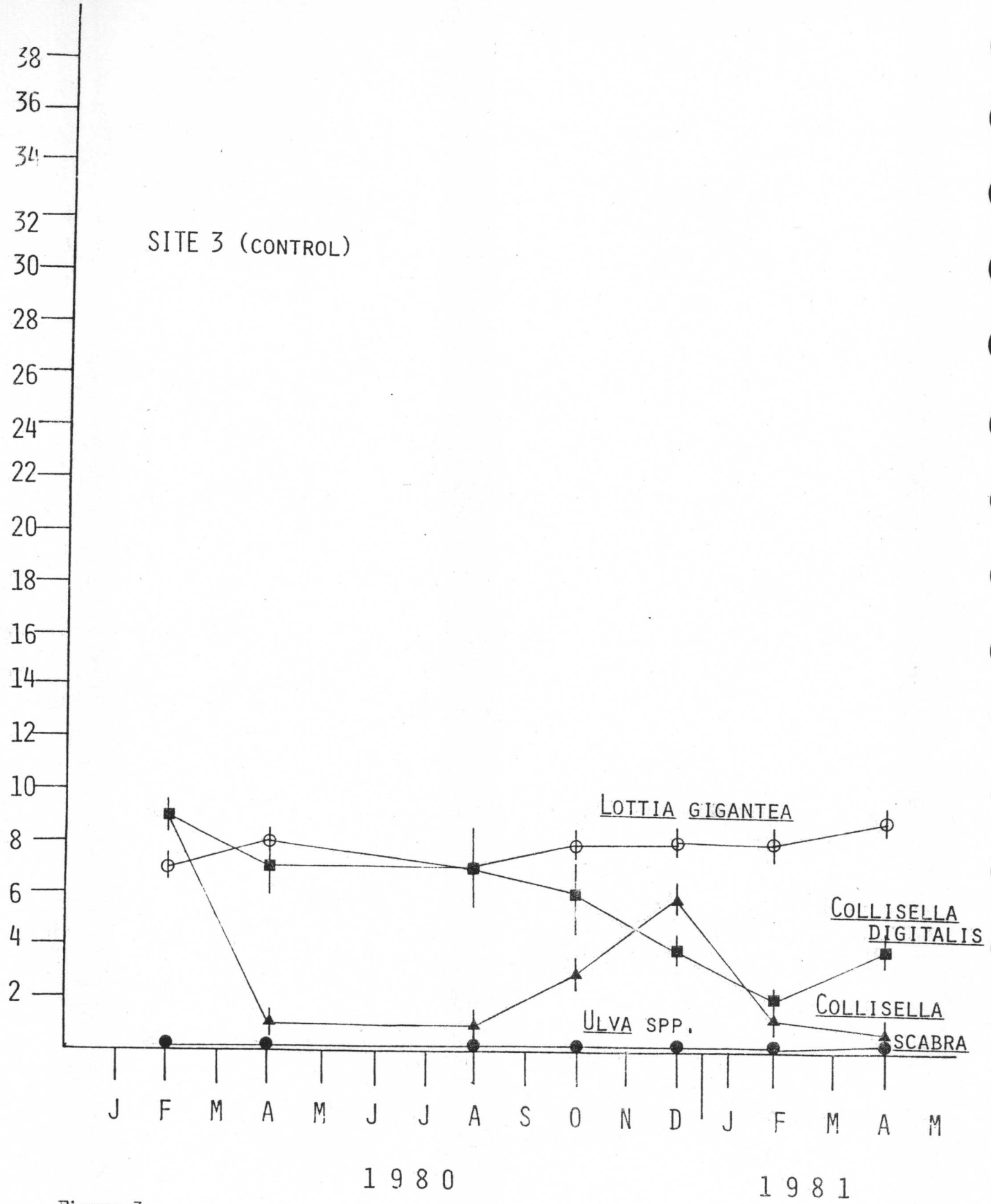
J F M A M J J A S O N D J F M A
1980
1981

Figure 2


SITE 3 (CONTROL)
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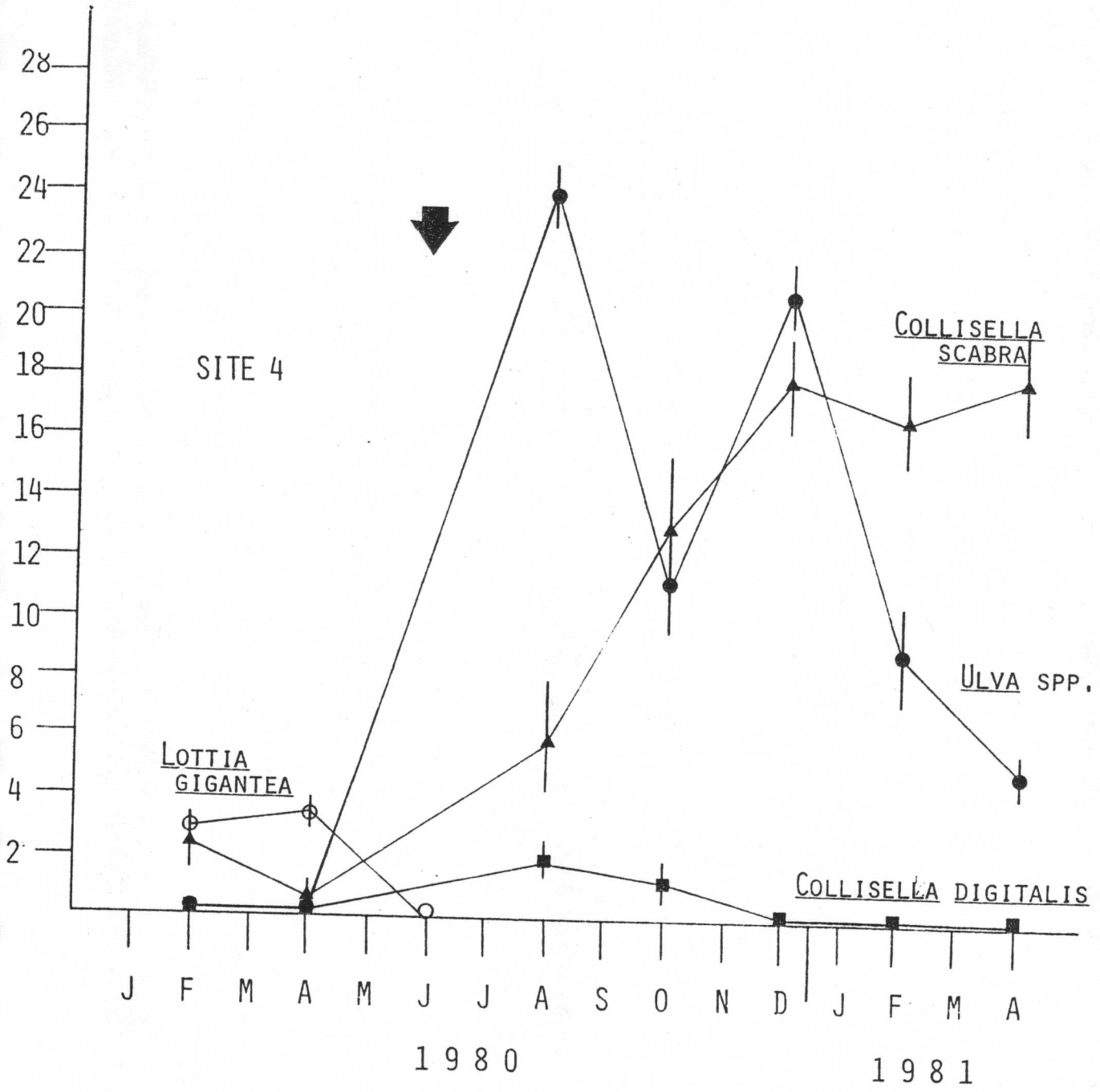
LOTTIA GIGANTEA
COLLISELLA DIGITALIS
COLLISELLA SCABRA
ULVA SPP.
J F M A M J J A S O N D J F M A M
1980
1981

Figure 3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SITE 4
COLLISELLA SCABRA
ULVA SPP.
LOTTIA GIGANTEA
COLLISELLA DIGITALIS
J F M A M J J A S O N D J F M A
1980
1981

Figure 4