14

Species of *Aphytis* occurring in the Neotropical region and their role in biological control

L. De Santis[1] and Irma S. de Crouzel[†]

[1] *Museo de La Plata, Buenos Aires Province, Argentine Republic*

We have recorded thirty-seven *Aphytis* species for the Neotropical region, including those introduced to control various scale insect pests, and these will be discussed herewith. Two of these species remain unidentified. For additional information, see the catalogs of Neotropical Chalcidoidea and supplements I and II (De Santis 1967, 1979, 1980, 1981, 1989). Supplement III by De Santis and Fidalgo, approved by the Second Argentine Congress of Entomology, La Cumbre (Cordoba, Argentina) December 1991, is scheduled to be published soon.

Some of these species (marked with an *) were used, or were intended to be used, in biological control in several countries in the Neotropical region. Different grades of success have resulted from these efforts, as reported in the consulted bibliography.

In order to put together the essential information about the species of *Aphytis* occurring in the region, we have repeated here some of the data published by Rosen and DeBach (1979). The purpose of this compilation is to provide information for future biological control research and to facilitate its application in those countries where access to proper bibliography is limited.

1. *Aphytis acutaspidis* Rosen and DeBach

As this species is closely related to *A. costalimai* (Gomes), we have reviewed collections of the Museo de La Plata and Fundacion Miguel Lillo, Tucumán, which had been labelled by us as belonging to the latter species, and have confirmed that identification. In the above-mentioned collections there are no specimens of

[†] Unfortunately, Dra Irma de Crouzel passed away on June 26, 1993.

Advances in the Study of Aphytis

A. acutaspidis. This is a South American species, male unknown, reared from *Acutaspis albopicta* (Cockerell) on coconut palm (Rosen and DeBach, 1979).

*2. *Aphytis africanus* Quednau

As Rosen and DeBach (1979) indicated, this African species occupies an intermediate position between the **lingnanensis** and **chrysomphali** groups. It is biparental, and was obtained from the California red scale, *Aonidiella aurantii* (Maskell), on citrus, although several other hosts and host plants have been recorded in relation to it.

In 1985 this species was introduced into Argentina by the Centro de Investigaciones para la Regulacion de Organismos Nocivos (CIRPON) in Tucumán, to control the California red scale. It was propagated in the laboratory on the oleander scale, *Aspidiotus nerii* Bouché, and was colonized two times on *A. aurantii* in Tucumán. There is evidence that it has become established. Due to the difficulties in identification, no control evaluation has been made up to the present.

3. *Aphytis amazonensis* Rosen and DeBach

We do not know this species, which belongs to the **proclia** group and was reared by Paul DeBach from unidentified Diaspididae on a wild jungle plant in Brazil. It is closely related to *A. griseus* Quednau (Rosen and DeBach, 1979).

4. *Aphytis anomalus* Compere

This is another species that is unknown to us. It is a member of the **vittatus** group from Brazil, found in Rio de Janeiro and Minas Gerais states. It was reared from the dictyospermum scale, *Chrysomphalus dictyospermi* (Morgan), on *Cassia imperialis*.

*5. *Aphytis aonidiae* (Mercet)

In the Museo de La Plata, the holotype and one paratype of *A. dubius* De Santis, the holotype of *A. dubius intermedius* De Santis, and one paratype of *A. citrinus* Compere are located. All of them are now considered junior synonyms of *A. aonidiae*. It is a Holarctic species, male unknown, originally reared ex *Aonidia lauri* Bouché, probably on *Laurus nobilis*. In Argentina it was reared from the oleander scale, *Aspidiotus nerii*, and from the San Jose scale, *Quadraspidiotus perniciosus* (Comstock) (De Santis, 1948a), while in Uruguay it was reared from *A. aurantii*. It is convenient to recall that Compere (1955) indicated that *A. citrinus* was only reared from the yellow scale, *Aonidiella citrina* (Coquillett).

This species was introduced to Chile against *Q. perniciosus* on citrus and on deciduous trees (González and Rojas, 1966; Vargas, 1987). Gonzalez (1981) pointed out the noxious effects that chemical pesticides may have upon it, when applied intensively.

6. *Aphytis chilensis* Howard

In the Museo de La Plata there exist numerous specimens identified by us, and a slide with South African specimens identified by H. Compere is available for comparison. The species is cosmopolitan, uniparental, with rare males, and is mainly known as a parasite of oleander scale on ivy, *Hedera* sp., although it has many other hosts. In Argentina, Crouzel (1973) reared it ex *A. aurantii, C. dictyospermi* and *A. nerii*. In Chile, Matta (1979) considered it an efficient natural enemy of *A. nerii* and of *Hemiberlesia lataniae* (Signoret). In Greece it was introduced against *A. nerii*, and was reported to be much better adapted to dry areas, where it complements the efficient action of *A. melinus* (Alexandrakis and Benassy, 1981; Alexandrakis and Neuenschwander, 1979, 1980; Argyriou and Kourmadas, 1980). The efficiency of this parasite, together with *Encarsia citrina* (Craw), against the oleander scale was also confirmed in Sicily, as was the harmful effect of intensive chemical treatments (Liotta, 1980).

*7. *A. chrysomphali* (Mercet)

In the Museo de La Plata there exist some specimens determined by Compere. This is a cosmomplitan, uniparental species, probably native to China. It prefers *Aonidiella aurantii* on citrus, and also on other plants, and was also reared ex *Aonidiella citrina, Chrysomphalus* spp., *Aspidiotus nerii* and other hosts. In Argentina, we studied this species in the La Plata area (Buenos Aires), ex *Chrysomphalus dictyospermi* (De Santis, 1935). Crouzel (1973) recorded it ex *Chrysompahlus aonidum* for the northwestern and eastern citrus regions, and Terán *et al.* (1985a) recorded it ex *A. aurantii* from Tucumán. In De Santis' catalogs (loc. cit.) it is reported as widely dispersed and with a long list of hosts in the Neotropical region. As Rosen and DeBach (1979) indicated for other countries, in Argentina this species has recently been displaced wherever *A. melinus, A. lingnanensis* and *A. holoxanthus*, more competitive parasites of destructive scale insect pests, have been introduced.

A. chrysomphali was imported into Chile in 1944 to control *Aonidiella aurantii*, but has not become established (Zuñiga 1991).

A. chrysomphali was introduced into Mexico to control *Aonidiella aurantii* on citrus, effecting a substantial success (Jiménez, 1961; Altieri *et al.*, 1989).

8. *Aphytis comperei* DeBach and Rosen

We do not know this species, found in Mexico and Jamaica. As reported by Schauff (1985), most of the *Aphytis* types which were at the University of California at Riverside have been transferred, as a permanent loan, to the Museum of Natural History in Washington, DC. Also, it is appropriate to quote here the excellent article by Woolley and Browning (1987), where they demonstrated that *A. comperei* is indeed different from *A. hispanicus* (Mercet). Both are important parasites of the chaff scale, *Parlatoria pergandii* Comstock, on citrus. The origin of this species is probably Oriental. It is thelytokous, male unknown, widely dispersed, and is a parasite of numerous Diaspididiae, mainly on citrus.

9. *Aphytis costalimai* (Gomes)

Refer to *A. acutaspidis*, above. *A. costalimai* is also closely related to *A. maculatipennis* (Dozier). It is a South American species, found in Brazil. Its preferred host is the Florida red scale, *Chrysomphalus aonidum* (L.) on citrus, but it was also reared from *Abgrallaspis cyanophylli* (Signoret) on ornamental plants and from *Pseudaonidia trilobitiformis* (Green) on citrus.

In Argentina it was found in Jujuy, and is usually encountered in Tucumán, according to material in the Museo de La Plata and Fundacion Miguel Lillo. In the Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, there is a specimen collected in Paraguay, erroneously determined as *Marietta leopardina* Motschulsky, by Brèthes. Crouzel (1973) and Terán *et al.* (1985b) recorded it ex *C. aonidum* on citrus in the northwestern region, and Fidalgo (1983) ex *Melanaspis paulistus* (Hempel).

10. *Aphytis cylindratus* Compere

This species, unknown to us, is an isolated member within the **chrysomphali** group. It is biparental. Rosen and DeBach (1979) consider it of Oriental origin and suggest that it has followed its hosts into the Neotropical region. It appears to have some specificity towards the species of the genus *Pseudaonidia*: It attacks *Pseudaonidia trilobitiformis* (Green) on citrus in Brazil and Trinidad, whereas in Japan it is the most efficient parasite of the camphor scale, *Pseudaonidia duplex* (Cockerell), on persimmon.

Azim (1963) studied the biology of *A. cylindratus* in Japan. It is considered of potential value for countries where its hosts are serious pests of various economic plants (Rosen and DeBach, 1979).

11. *Aphytis desantisi* DeBach and Rosen

We do not know this South American species, typical of the **proclia** group. A.L. Terán saw it for the first time at Siambon (Tucumán, Argentina), ex *Aonidiella aurantii* on orange trees. Rosen and DeBach (1979) consider it a potential candidate for use against that pest.

*12. *Aphytis diaspidis* (Howard)

In the Museo de La Plata there is a slide with specimens for comparison, determined by H. Compere. This is a uniparental species, but biparental "forms" have been recorded from California and Peru. It is cosmoplitan and polyphagous. In Argentina, Crouzel *et al.* (1979) reared it ex *Aonidiella aurantii* in Corrientes. Matta and Hichins (1979) regarded it as an efficient enemy of *Aonidomytilus espinosai* (Porter), which infests *Fabiana imbricata*, a medicinal plant, in northern Chile, and suggested its use in the south of the country together with *Encarsia aurantii*

(Howard). González (1981) stated that it is an important natural enemy of the San Jose scale, but its efficacy is diminished by intensive treatments with chemical pesticides.

A. diaspidis was imported into the Bermuda Islands in 1924 from Italy against the white peach scale, *Pseudaulacaspis pentagona* (Targioni Tozzetti) on oleander, resulting in substantial control (DeBach, 1964).

Between 1909 and 1911, the following species were imported into Peru against the lesser snow scale, *Pinnaspis strachani* (Cooley), a cotton pest: *Aphytis fuscipennis* (Howard) (= *A. diaspidis*) (already present in the country) from Barbados, *A. diaspidis* from Ceylon, and *A. mytilaspidis* (Le Baron) from Hawaii. Both species remain established and exert, individually, partial control (Townsend, 1912).

13. *Aphytis haywardi* (Blanchard)

In the Museo de La Plata there are paratypes of this South American species, reared by K.J. Hayward from *Aonidomytilus espinosai* (Porter) in Concordia (Entre Rios). It was also found in Uruguay, on an undetermined scale insect on *Baccharis* sp. The male is unknown.

14. *Aphytis hispanicus* (Mercet)

See the discussion of *A. comperei*, above. A slide with specimens identified by H. Compere is kept in the Museo de La Plata for comparison. *A. hispanicus* is a uniparental, South Palearctic species, closely related to *A. proclia* (Walker). Although it has been reared from several hosts, it is an important natural enemy of the chaff scale, *Parlatoria pergandii* Comstock. In Argentina, Crouzel (1973) recorded it ex *Parlatoria cinerea* Doane et Hadden on orange trees.

*15. *Aphytis holoxanthus* DeBach

This species is closely related to *A. lingnanensis* Compere. Its origin is Oriental, and it is biparental. It is an important parasite, almost specific to the Florida red scale, *Chrysomphalus aonidum* (= *C. ficus* Ashmead) on citrus. It was found on the same host by Ceballos and Hernandez (1988) in Cuba. After the spectacular success obtained in Israel, where it was introduced in 1956–1957 from Hong Kong, it was imported with similar results into Brazil and Mexico (DeBach and Rosen, 1976).

A. holoxanthus was imported into Argentina in 1970 by CIRPON from the University of California at Riverside, to control *C. aonidum*. The same year it was colonized in Tucumán; at present, there only exist sporadic foci of the Florida red scale in citrus plantations where the parasite does not exist. Other important parasites of the scale have been displaced almost completely by *A. holoxanthus* (Terán *et al.*, 1985b).

Imported into Mexico in 1957, in less than one year *A. holoxanthus* effected substantial control of *C. aonidum* in the Morelos region (Jiménez, 1961). A few years later, complete control was reported (Maltby *et al.*, 1968).

*16. *Aphytis lepidosaphes* Compere

In the Museo de La Plata there are syntypes of this species. Its origin is in the Orient: southern China and Taiwan. It is biparental, gregarious, highly specific to the purple scale, *Lepidosaphes beckii* (Newman), an important citrus pest. Its biology was studied by DeBach and Landi (1961). After its introduction into California (1948–49), it was successfully imported into numerous countries, several of them in the Neotropical region, to control the purple scale. In others, it was transferred accidentally and was established by ecesis (Rosen and DeBach, 1979). De Moraes and Da Silva (1987) state that *A. lepidosaphes* is the most important natural enemy of the purple scale in Rio Grande do Sul, Brazil. Arias Reveron (1990) has found this species in Costa Rica, where it destroys also the Glover scale, *Lepidosaphes gloverii* (Packard).

A. lepidosaphes was found in Tucumán, Argentina in 1970, during Paul DeBach's visit while he was the Scientific Coordinator of the Armored Scale Insect Biological Control Project of the International Biological Program. CIRPON imported this species in 1973 from the University of California, Riverside; it was propagated in the laboratory and released to attack *C. beckii* in heavily infested citrus plantations in Tucumán. It was quickly established and has effected substantial control in that region (Terán *et al.*, 1985b).

A. lepidosaphes was imported into Brazil and has become established, effecting complete control (DeBach and Rosen, 1991).

A. lepidosaphes was imported from California into Chile and became established in 1951. Although at first it caused a significant reduction in purple scale populations, its overall action was not very effective, and *L. beckii* is still considered the scale insect of greatest importance in the country. Extreme problems appear where the parasite is absent (Rojas, 1987).

Substantial control was obtained in Ecuador upon the introduction of *A. lepidosaphes* (Jiménez, 1961; Altieri *et al.*, 1989).

Introduction of *A. lepidosaphes* into El Salvador was followed by complete and substantial control in the country, depending on the regions (Laing and Hamai, 1976).

Guadaloupe and Jamaica have also imported the parasite, obtaining complete and substantial control, respectively (Laing and Hamai, 1976).

The species was imported from California into Mexico and released in several locations. By 1962, the purple scale was not a problem any more, and control is effective (Rosen and DeBach, 1979).

A. lepidosaphes was imported from California into Peru (Ebeling, 1957); it became established and effected substantial control with high levels of parasitization, producing much mortality in purple scale populations. This has reduced the urgency to apply chemical treatments (Beingolea, 1969).

A. lepidosaphes was also imported into Puerto Rico, attaining complete and substantial control in various locations (Laing and Hamai, 1976).

*17. *Aphytis lingnanensis* Compere

Two varieties of this biparental species have been used in the biological control of pest scale insects.

(1) *A. lingnanensis*, native of China and Taiwan. At the Museo de La Plata there are syntypes of this variety and some specimens, from among those introduced into Chile, which were sent to us by the La Cruz insectary, Quillota. It is gregarious and possesses habits of mutilation and predatory host feeding, augmenting the mortality caused by parasitism. Its preferred host is *Aonidiella aurantii* on citrus, but other hosts on other host plants have been recorded. Lately, it was found in Australia ex *Lepidosaphes beckii*. In the Neotropical region it has been recorded from Mexico, Trinidad, Puerto Rico and El Salvador (Rosen and DeBach, 1979).

The Instituto Nacional de Tecnología Agropecuaria (INTA), Castelar, imported it into Argentina from the University of California, Riverside in 1961, 1966, 1967 and 1971 and from the La Cruz Insectary, Chile in 1962 and 1963. It was massively propagated and later on released in the provinces of Corrientes (4000 adults) and Buenos Aires (3000 adults) in the Littoral citrus region, and several thousands in Tucumán and Jujuy in the Northwest citrus region. It has become established in the four provinces, and at present performs partial control in Corrientes and Jujuy, but its action is weakened by applications of chemical pesticides. In Buenos Aires, its population remains at low densities (Crouzel *et al.*, 1973; Terán *et al.*, 1985a).

This variety of *A. lingnanensis* was imported into Chile from the University of California, Riverside in 1957 to control *A. aurantii* on citrus, became established and has effected partial control. In the last 15 years it has no longer been propagated in insectaries (Rojas, 1987).

This variety was imported into Mexico against *Chrysomphalus aonidum* and *A. aurantii*; substantial control has been obtained (Jiménez, 1961).

Imported into Peru from Trinidad in 1975 to control *Aspidiotus nerii* on olives, this parasite has not become established (O. Beingolea, unpublished).

(2) *A. lingnanensis,* native of Hong Kong (designated HK-L). This variety parasitizes the citrus snow scale, *Unaspis citri* (Comstock), on citrus. At the beginning it was known as *A.* prox. *lingnanensis*, until crossing tests have revealed its true identity (Rosen and DeBach, 1979). Jerez Ruiz (1983) recorded it ex *U. citri* from Cuba.

Imported into Argentina by CIRPON in 1976 from the University of California, Riverside, this variety was propagated in the insectary and released in Tucumán and Castelar (Buenos Aires) during the same year. It has become established in both provinces, but appears not to have adapted completely to the citrus snow scale in Tucumán (Crouzel and Merluzzi, 1980; Terán *et al.*, 1985b).

In order to control the citrus snow scale in Costa Rica, 4000 specimens were imported from the University of Florida in 1986. Releases were made in Turrialba and Acosta, but it is not known whether the parasite has become established (Hernandez Ramirez, 1991).

Imported from the University of California, Riverside into Peru to control *Aspidiotus nerii* on olive trees, but has not become established (O. Beingolea, unpublished).

*18. *Aphytis* prox. *lingnanensis* Compere

"[A] culture obtained in 1965 from the citrus snow scale, *Unaspis citri* (Comstock), on citrus in Florida and designated "R-65-23", poses a (. . .) puzzling problem.

Morphologically indistinguishable from *lingnanensis* and "2002" [obtained from the coconut scale, *Aspidiotus destructor* Signoret], it hybridizes fairly readily with "2002" and may be considered a semispecies in relation to that form. However, "R-65-23" exhibits strong reproductive isolation in relation to *lingnanensis*, (. . .). On the basis of available information, therefore, "R-65-23" must be regarded as biologically distinct from *lingnanensis*, although some gene exchange may theoretically occur between them, with "2002" serving as an intermediary form" (Rosen and DeBach, 1979).

In 1987, CIRPON imported a shipment of these little wasps into Argentina from Florida. Adult wasps were released one year later, and establishment was apparently achieved (A. Terán, CIRPON, personal communication, 1990).

*19. *Aphytis* prox. *lingnanensis* Compere

"A series [of *Aphytis*] obtained from the Glover scale, *Insulaspis* [=*Lepidosaphes*] *gloverii* (Packard), on citrus in Sinaloa, Mexico, appears to be somewhat [different from] typical *lingnanensis* (. . .). These slight differences, as well as the unusual host record, seem to indicate that this may possibly be yet another distinct form. However, no biological information is available regarding it (. . .). Further biosystematic investigation will undoubtedly reveal additional biologically distinct forms which are at present referred to *lingnanensis*" (Rosen and DeBach, 1979).

CIRPON imported a shipment of these insects into Argentina in 1987 from Mazatlán, Mexico, for the control of *L. gloverii*. The wasps were propagated in the laboratory and released in Tucumán and Jujuy in the same year. The species has become established in Tucumán and the Glover scale has practically disappeared from citrus. Therefore, this project may be considered a complete success.

20. *Aphytis maculatipennis* (Dozier)

We do not know this Caribbean species, included in the **vittatus** group by Rosen and DeBach (1979); it is quite similar to *A. costalimai*. It was reared in Haiti ex *Diaspidiotus* sp. on mahogany.

21. *Aphytis maculicornis* (Masi)

The origin of this species is Palearctic. Several of its hosts are known, among them *Parlatoria oleae* (Colvée) on *Ligustrum* sp. In Mexico, it attacks *Aspidiotus nerii*. It may be either biparental or uniparental. The species determined as *A. maculicornis* in Argentina (De Santis, 1948b) is probably misidentified, and a review is needed.

22. *Aphytis margaretae* DeBach and Rosen

We do not know this American species, whose authors placed in the **lingnanensis**

group, close to *A. lingnanensis*. It was found in Mexico and Brazil, as a parasite of the following scale insects: the cactus scale, *Diaspis echinocacti* (Bouché) on *Opuntia* sp., the coconut scale, *Aspidiotus destructor* Signoret on coconut palms, the cyanophyllum scale, *Abgrallaspis cyanophylli* (Signoret) on ornamental trees, and *Pseudoparlatoria* sp. on honeysuckle. It is considered an important natural enemy of the coconut scale in areas where this insect causes damage of economic importance (Rosen and DeBach, 1979).

23. *Aphytis melanostictus* Compere

In the Museo de La Plata there are paratypes of this peculiar species, placed by Rosen and DeBach (1979) in the **vittatus** group. It is a North American insect, which is also found in Mexico ex *Clavaspis subsimilis* (Cockerell) on *Bursera microphylla*. McClain *et al.* (1990) reported it from sticky traps in deciduous fruit tree orchards in North Carolina.

*24. *Aphytis melinus* DeBach

In the Museo de La Plata there are some specimens submitted by the La Cruz Insectary, Chile, which are part of the shipment they received during its introduction into that country. It is similar to *A. holoxanthus*, biparental, and native to India and Pakistan. It is the only *Aphytis* species which commonly attacks both *Aonidiella aurantii* and *Aonidiella citrina*; it also parasitizes *Chrysomphalus dictyospermi* on citrus. It is easily reared in the laboratory on *Aspidiotus nerii*. It has been used in several countries to control the California red scale.

CIRPON and INTA Castelar imported it into Argentina from the University of California, Riverside and the La Cruz Insectary, Chile in 1966, 1967 and 1971. It was propagated in the laboratory, and during the 1970s massive releases took place in citrus orchards heavily infested with *A. aurantii*, at various locations in the provinces of Tucumán, Buenos Aires and Corrientes. It was rapidly established in the three provinces, exerting substantial control in Buenos Aires and partial control in Corrientes. It was also released, but at a lower scale, in Misiones and Jujuy (Crouzel *et al.*, 1973). It became established in the latter province, where it still exists although its influence has been weakened by the action of frequent chemical pesticide applications. It has dispersed into Salta and Santiago del Estero, where it has been recovered. It is interesting to note some trial results:

1. At Bella Vista, Corrientes, 6500 *A. melinus* adults were released in a heavily infested citrus orchard between 1966 and 1967; the parasite was established and still remains there, exerting partial control. In samples taken in the region in 1990 and 1991, parasitization by *Aphytis* spp. was 84.5% and 41.6%, respectively.
2. At San Pedro, Buenos Aires, 90,000 *A. melinus* adults were released during one year (1971–72) in an abandoned orchard of 3500 orange trees, 10 years of age. The parasites rapidly adapted to the region, significantly reducing the California

red scale population. At the end of the experiment the following numbers were recorded: Average of live scale insects per leaf: reduced from 35.20 to 0.08. Scale insect mortality: increased from 21.0% to 86.04%. Parasitization: increased from 4.08% to 23.7%. Fruit production: 1212 boxes in the sector where *A. melinus* was active, vs. 11 boxes in the sector where parasite activity was inhibited.

Parasite efficacy has extended progressively into the San Pedro Experiment Station region (Crouzel *et al.*, 1973). In 1986, substantial control was attained and has been maintained steadily.

3. At San Roque, Corrientes. The objective of this trial, of little more than 2 years duration (1975–78), was to investigate the possibility of attaining biological control of the California red scale through the joint action of *A. melinus* and an endoparasite, *Comperiella bifasciata* Howard. In a lot of 1000 orange trees within a commercial orchard, 50,800 *Aphytis* and 66,600 *Comperiella* were periodically released. During the initial survey, *A. melinus* was recovered for the first time in Corrientes. It had been released in Bella-Vista, 70 km away, in 1966–67, thus revealing the capacity of the species for dispersal. *Comperiella* established itself slowly, and by the trial's end it was possible to declare it as an efficient complement to the action of *A. melinus*, up to the point where it could be stated that control through the combined effect of both parasites has resulted in a sub-economic level of less than 3 California red scales per fruit (Crouzel *et al.*, 1979).

Other experiments failed because the fruit producers felt they had to apply insecticides according to marketing requirements, even though the effects of the natural enemies had begun to be noticed.

A. melinus was imported into Chile in 1966 from the University of California, Riverside. For many years it was propagated in the insectary on *Aspidiotus nerii*, which is also controlled by it in the field. Outstanding control of *Aonidiella aurantii* on citrus was obtained (Rojas, 1987).

DeBach sent this parasite to Peru from the University of California, Riverside to control *Aspidiotus nerii* on olive trees, but the species failed to become established (O. Beingolea, unpublished).

*26. *Aphytis mytilaspidis* (Le Baron)

In the collections of the Museo de La Plata there are specimens of this cosmopolitan species, reared in 1959 from the San Jose scale, *Quadraspidiotus perniciosus* (Comstock) on a *Crataegus* hedge in Riverside, and determined by DeBach. It was introduced into Peru in 1912 against the lesser snow scale, *Pinnaspis strachani* (Cooley) (Townsend, 1912) and into Bermuda in 1947 against the palmetto scale, *Comstockiella sabalis* (Comstock) (Cock, 1985). In Chile it attacks the purple scale, *Lepidosaphes beckii* (Newman) and the San Jose scale (Prado, 1991). However, these records need to be revised.

27. *Aphytis notialis* De Santis

This is a biparental, South American species. Very often have we received material from Argentina and Chile, as a parasite of the oleander scale, *Aspidiotus nerii*, on *Aucuba japonica*. We consider it a potentially valuable natural enemy, to be taken into account against this scale insect wherever it is a pest of cultivated and useful plants. Matta (1979) has reported that *A. notialis* also attacks the latania scale, *Hemiberlesia lataniae* (Signoret), together with other parasites in Chile, noting that they are so effective as to eliminate the need for any chemical treatments.

28. *Aphytis obscurus* DeBach and Rosen

In the Museo de La Plata there are paratypes, and in the Fundacion Miguel Lillo some specimens, of this biparental South American species, found in Argentina. It parasitizes the cactus scale, *Diaspis echinocacti* (Bouché), and is very common in Tucumán.

*29. *Aphytis paramaculicornis* DeBach and Rosen

This is the so-called "Persian *Aphytis*", native to southwestern Asia. It is biparental and a solitary parasite; only seldom do two individuals develop upon the same host. It prefers the olive scale, *Parlatoria oleae* (Colvée), and develops easily on the oleander scale, *Aspidiotus nerii*, but can be reared also on *Diaspis echinocacti* and *Hemiberlesia lataniae*.

A. paramaculicornis was imported into Argentina in 1972 and again in 1981 from the University of California, Riverside against *Parlatoria oleae*, which is a severe pest of olives in Mendoza. However, the attempt to rear it failed, and therefore it could not be released.

30. *Aphytis perplexus* Rosen and DeBach

This species is similar to *A. costalimai* and *A. acutaspidis*. A South American species, it was found in Brazil ex the latania scale, *Hemiberlesia lataniae*, on ornamental palms. Rosen and DeBach (1979) recommended its introduction into California.

31. *Aphytis pinnaspidis* Rosen and DeBach

This is a South American member of the **proclia** group. It was found in Mexico, El Salvador and Brazil, parasitizing *Pinnaspis strachani* (Cooley) on *Solanum juribeba* and *Hibiscus* sp., *Pinnaspis* sp. on date palm, and *Aonidiella aurantii* on lime, *Citrus aurantifolia* (Rosen and DeBach, 1979).

32. *Aphytis proclia* (Walker)

A Holarctic, biparental species, widely dispersed. It has been obtained from diverse hosts, but in Mexico it was found parasitizing *Chrysomphalus dictyospermi* on orange and rose. In Rosen and DeBach's opinion (1979), the determination of Argentine specimens as *A. proclia* (De Santis, 1948a) is erroneous and should be referred to *A. diaspidis*. The same authors regard *A. proclia* as a promising species that should be included in biological control projects against the San Jose scale, *Quadraspidiotus perniciosus*, the white peach scale, *Pseudaulacaspis pentagona*, and other important pests that serve as its hosts.

33. *Aphytis punctaticorpus* (Girault)

A Neotropical species, described from Mexico, with many characteristics of the genus *Marietta*. Rosen and DeBach (1979) regarded it as "an unrecognizable species of highly questionable status, probably related to the **vittatus** group", because of the poor condition of the two syntype specimens, deposited in the US National Museum of Natural History, Washington, DC.

*34. *Aphytis roseni* DeBach and Gordh

We do not know this African, biparental species. It was collected in Uganda ex the rufous scale, *Selenaspidius articulatus* (Morgan), on citrus (DeBach and Gordh, 1974).

In 1970, this species was imported into Peru from Uganda. It was successfuly propagated and colonized to control the rufous scale, which is a very serious pest of citrus in Peru. By mid-1975 the project was considered a complete success (Beingolea, 1977, 1989 and Chapter 6, this volume).

35. *Aphytis salvadorensis* Rosen and DeBach

We do not know this biparental species, which is similar to *A. melanostictus*. It is native to Central America, and was reared in El Salvador from an undetermined scale insect host (Rosen and DeBach, 1979).

36. *Aphytis simmondsiae* DeBach

This species has recently been found in Mexico, parasitizing the jojoba scale, *Diaspis simmondsiae* Ferris (DeBach, 1984).

37. *Aphytis tucumani* Rosen and DeBach

This species was discovered by P. Fidalgo in Chaco and Tucumán, Argentina;

reared from *Diaspis* sp., probably *D. echinocacti* (Bouché). Specimens are deposited in the Fundacion Miguel Lillo.

Conclusions

The role of *Aphytis* spp. in classical biological control projects in the Neotropical region is summarized in Tables 1, 2 and 3.

Important survey, research and description work has been done in the Neotropical region with local species of *Aphytis*. However, in most of the Neotropical countries utilization of these parasites has been limited to several species of acknowledged efficiency. In the majority of the experiments and projects, the option chosen was classical biological control, that is to say, importation of exotic natural enemies.

From Table 1 it can be seen that out of the list of 37 species or strains of *Aphytis* recorded in the Neotropical region, 13 have been imported by 12 countries for the control of 11 pest scale insects. Of these 13 species, six are prominent due to the impact exerted on their respective hosts.

Aphytis lepidosaphes, introduced into ten countries, has produced substantial and complete control of the purple scale, *Lepidosaphes beckii*, on citrus in almost all of them.

Aphytis lingnanensis (from China and Taiwan), with positive results over the California red scale, *Aonidiella aurantii* and the Florida red scale, *Chrysomphalus aonidum*, on citrus. It has not effected the same degree of control over the oleander scale, *Aspidiotus nerii*, on olive trees.

Aphytis holoxanthus has demonstrated its power against *Chrysomphalus aonidum* on citrus in the three countries where it has become established.

Aphytis melinus, a species with great capacity for adaptation as well as a quick dispersal ability, has effected substantial and partial control over *Aonidiella aurantii* on citrus in three of the importing countries. It also has failed over *Aspidiotus nerii* on olives.

Aphytis roseni exserted outstanding control in the 1970s over the rufous scale, *Selenaspidus articulatus*, a serious pest of citrus in Peru.

Aphytis prox. *lingnanensis*, native of Sinaloa, Mexico, revealed itself as a good control agent of the glover scale, *Lepidosaphes gloverii*. In 1987, the glover scale disappeared from citrus orchards in Tucumán, Argentina, immediately after this parasite had been released.

With respect to the target pests (Table 2), most of the projects have had positive results, which is remarkable considering the conditions under which such work has to be done in these countries. Complete control was achieved over *Chrysomphalus aonidum, Lepidosaphes beckii, L. gloverii* and *Selenaspidus articulatus*; numerous cases of substantial control over *Aonidiella aurantii, Chrysomphalus aonidum* and *Lepidosphes beckii* as well as cases of partial control have been recorded, all of them in citrus plantations. In some cases, establishment of imported natural enemies was verified, but there has been no opportunity, or it has been impossible, to evaluate the degree of control attained. The negative cases corresponded to lack of establishment – of *Aphytis* spp. on *Aspidiotus nerii* on olive and on *Pinnaspis strachani* on cotton. It would be useful to analyze the reasons for these failures.

Table 1. Role of *Aphytis* spp. in classical biological control projects in the Neotropical region

Imported *Aphytis* species	Origin Host insects Host plants	Importing country	Year of importation	Target pest	Infested plant	Recorded results[a]	Total number of							
							Importing countries	Target pests	CC	SC	PC	E	NR	N
1. *africanus*	Africa *Aonidiella aurantii* citrus	Argentina	1985	*A. aurantii*	citrus	E	1	1				1		
2. *aonidiae*	Holarctic *Aonidia lauri* *Laurus nobilis*	Chile	–	*Quadraspidiotus perniciosus*	citrus	E	1	1				1		
3. *chrysomphali*	Cosmopolitan *Aonidiella aurantii* *Aonidiella citrina* *Chrysomphalus dictyospermi* citrus other plants	Chile	1944	*A. aurantii*	citrus	NE	2	1		1				1
		Mexico	—	*A. aurantii*	citrus	SC								
4. *diaspidis*	Cosmopolitan *Aulacaspis rosae* *Diaspis echinocacti* *Hemiberlesia lataniae* *Hemiberlesia rapax* *Aspidiotus nerii* other scale insects several host plants	Bermuda	1924	*Pseudaulacaspis pentagona*	oleander	SC	2	2		1	1			
		Peru	1909, 1911	*Pinnaspis strachani*	cotton	PC								

5. *holoxanthus*	Orient	Argentina	1970	*C. aonidum*	citrus	SC	3	1	2	1			
	Chysomphalus aonidum	Brazil	—	*C. aonidum*	citrus	CC							
	citrus	Mexico	1957	*C. aonidum*	citrus	CC							
6. *lepidosaphes*	Orient	Argentina	1973	*L. beckii*	citrus	SC	10	1	5	9	1		
Lepidosaphes	Brazil	—		*L. beckii*	citrus	CC-SC							
	beckii	Chile	1951	*L. beckii*	citrus	PC							
	citrus	Ecuador	—	*L. beckii*	citrus	SC							
		El Salvador	—	*L. beckii*	citrus	CC-SC							
		Guadaloupe	—	*L. beckii*	citrus	CC-SC							
		Jamaica	—	*L. beckii*	citrus	CC-SC							
		Mexico	1960?	*L. beckii*	citrus	SC							
		Peru	1957	*L. beckii*	citrus	SC							
		Puerto Rico	—	*L. beckii*	citrus	CC-SC							
7. *lingnanensis* (I)	China–Taiwan	Argentina	1961–1971	*A. aurantii*	citrus	PC	4	3		2	2		1
	Aonidiella aurantii												
	citrus	Chile	1957	*A. aurantii*	citrus	PC							
		Mexico	—	*A. aurantii*	citrus	SC							
				Chrysomphalus aonidum	citrus	SC							
		Peru	1975	*Aspidiotus nerii*	olive	NE							
lingnanensis (II)	Hong Kong	Argentina	1976	*U. citri*	citrus	E	3	2			1		1
	Unaspis citri	Costa Rica	1986	*U. citri*	citrus	E?					1?		
	citrus	Peru	—	*Aspidiotus nerii*	olive	NE							
8. prox. *lingnanensis*	USA	Argentina	1987	*U. citri*	citrus	E	1	1				1	
	Unaspis citri citrus												
9. prox. *lingnanensis*	Mexico	Argentina	1987	*L. gloverii*	citrus	CC	1	1	1				
	Lepidosaphes gloverii citrus												

Table 1 continued

Imported *Aphytis* species	Origin Host insects Host plants	Importing country	Year of importation	Target pest	Infested plant	Recorded results[a]	Total number of							
							Importing countries	Target pests	CC	SC	PC	E	NR	N
10. *melinus*	India-Pakistan *Aonidiella aurantii*	Argentina	1966–71	*A. aurantii*	citrus	SC-PC	3	2		2	1		1	
	Aonidiella citrina	Chile	1966	*A. aurantii*	citrus	SC								
	Chrymsophalus dictyospermi citrus	Peru	1977	*Aspidiotus nerii*	olive	NE								
11. *mytilaspidis*	Holarctic *Lepidosaphes ulmi* apple	Chile	—	*Quadraspidiotus perniciosus*	citrus	PC	2	2			1			1
		Peru	1911–12	*Pinnaspis strachani*	cotton	NE								
12. *paramaculicornis*	SW Asia *Parlatoria oleae* *Aspidiotus nerii* olive	Argentina	1972, 1981	*P. oleae*	olive	NR	1	1					1	
13. *roseni*	Africa *Selenaspidus articulatus* citrus	Peru	1970	*S. articulatus*	citrus	CC	1	1		1				

[1] CC, complete control; SC, substantial control; PC, partial control; E, established; NR, not released; N, negative.

Table 2. Pests against which *Aphytis* spp. were applied in the Neotropical region

Target pest	Country	*Aphytis* spp.	Host plant	Results[a]					
				CC	SC	PC	E	NR	N
1. *Aonidiella aurantii*	Argentina	*A. africanus*	citrus					x	
		A. lingnanensis (I)					x		
		A. melinus				x	x		
	Chile	*A. chrysompahli*	citrus						x
		A. lingnanensis (I)						x	
		A. melinus				x			
	Mexico	*A. chrysompahli*	citrus			x			
		A. lingnanensis (I)				x			
2. *Aspidiotus nerii*	Peru	*A. lingnanensis* (I)	olive						x
		A. lingnanensis (II)							x
		A. melinus							x
3. *Chrysomphalus aonidum*	Argentina	*A. holoxanthus*	citrus		x				
	Brazil	*A. holoxanthus*			x				
	Mexico	*A. holoxanthus*			x				
		A. lingnanensis (I)				x			
4. *Lepidosaphes beckii*	Argentina	*A. lepidosaphes*	citrus		x				
	Brazil	*A. lepidosaphes*			x	x			
	Chile	*A. lepidosaphes*					x		
	Ecuador	*A. lepidosaphes*				x			
	El Salvador	*A. lepidosaphes*			x	x			
	Guadaloupe	*A. lepidosaphes*			x	x			
	Jamaica	*A. lepidosaphes*			x	x			
	Mexico	*A. lepidosaphes*				x			
	Peru	*A. lepidosaphes*				x			
	Puerto Rico	*A. lepidosaphes*			x	x			
5. *Lepidosaphes gloverii*	Argentina	*A.* p. *lingnanensis*	citrus		x				
6. *Parlatoria oleae*	Argentina	*A. paramaculicornis*	olive						x
7. *Pinnaspis strachani*	Peru	*A. diaspidis*	cotton			x			
		A. mytilaspidis							x
8. *Pseudaulacaspis pentagona*	Bermuda	*A. diaspidis*	laurel			x			
9. *Quadraspidiotus perniciosus*	Chile	*A. aonidiae*	citrus				x		
		A. mytilaspidis				x			
10. *Selenaspidus articulatus*	Peru	*A. roseni*	citrus		x				
11. *Unaspis citri*	Argentina	*A. lingnanensis* (II)	citrus				x		
		A. p. *lingnanensis*	citrus				x		
	Costa Rica	*A. lingnanensis* (II)					x?		

[a] CC, complete control; SC, substantial control; PC, partial control; E, established; NR, not released; N, negative.

With respect to the importing countries (Table 3), we can say that Chile has been in the leading position in the Neotropical Region because of the important projects of production and mass releases of *Aphytis* spp. carried out over many years, in addition to invaluable collaboration provided to neighboring countries. Chile has imported six species, five of which have effected positive results. Argentina has

Table 3. Importing countries of *Aphytis* spp. in the Neotropical region and results obtained

Country	Number of *Aphytis* spp. imported	Results[a]							
		CC	SC	PC	E	NE	NR	Postive	Negative
1. Argentina	9	1	3	2	3		1	8	
2. Brazil	2	2	1					2	
3. Chile	6		1	3	1	1		5	1
4. Costa Rica	1				1?			1?	
5. Ecuador	1		1					1	
6. El Salvador	1	1	1					1	
7. Guadaloupe	1	1	1					1	
8. Bermuda	1		1					1	
9. Jamaica	1	1	1					1	
10. Mexico	4	1	3					4	
11. Peru	7	1	1	1		4		3	4
12. Puerto Rico	1	1	1					1	

[a] CC, complete control; SC, substantial control; PC, partial control; E, established; NR, not released; N, negative.

introduced nine species, of which eight have effected positive results whereas the remaining one could not be released because its laboratory propagation was not successful. It would be neccessary to try other techniques. Peru has had seven importations and has experienced good positive results with *Aphytis roseni*. Besides these importing countries, important biological control projects have been carried out in Colombia and Caribbean islands, particularly in Trinidad, the Dominican Republic and others. To conclude this review, we should say that in order to make such a valuable genus as *Aphytis* profitable, much more work needs to be done, not only on the application aspect, as is often suggested, but also in basic research. Unfortunately, the countries of the Neotropical Region show their underdeveloped status even in these aspects, and are still lagging behind those other countries which are at the vanguard.

Acknowledgements

The authors express their sincere and deep thanks for valuable collaboration received from M.A. Vaughan (FAO) and S. Rojas Poblete (Insectario La Cruz Quillota), Chile; P. Aguilar P. (Department of Biology, UNA) and O.D. Beingolea G. (Agricultural Entomology), Peru; J. Hernández R. (Entomology Department, Ministry of Agriculture and Cattle Production) S. J. de Costa Rica; A.L. Terán (CIRPON), Tucumán, Argentina and the INTA research workers in Argentina: M.L. Zaneli (Department of Statistics), J.M. Benavent (EEA Salta), M.F. Garcia (EEA Luján de Cuyo, Mendoza) and S. Caceres (EEA Bella Vista, Corrientes).

References

Alexandrakis, V. and C. Benassy. 1981. Essai de lutte biologique sur olivier en Crete par utilization d'*Aphytis melinus* DeBach (Hym. Aphelinidae) parasite d'*Aspidiotus nerii* Bouché (Hom. Diaspididae). Acta Oecol. Oecol. Applic. **2**: 13–25.

Alexandrakis, V. and P. Neuenschwander. 1979. Influence de la poussiere des chemins sur *Aspidiotus nerii* Bouché (Hom. Diaspididae) et son parasite principal, *Aphytis chilensis* How. (Hym. Aphelinidae) observes sur olivier. Ann. Zool. Ecol. Anim. **11**: 171–184.

Alexandrakis, V. and P. Neuenschwander. 1980. Le role d'*Aphytis chilensis* (Hym. Aphelinidae) parasite d'*Aspidious nerii* (Hom. Diaspididae) sur olivier en Crete. Entomophaga **25**: 61–71.

Altieri, M.A., J. Trujillo, S. Campos, C. Klein-Koch, C.S. Golg and J.R. Quezada. 1989. El control biologico clasico en America Latina en su contexto historico. Manejo Integrado de Plagas (Costa Rica) **12**: 82–107.

Argyriou, L.C. and A.L. Kourmadas. 1980. The phenology and natural enemies of *Aspidiotus nerii* Bouché in central Greece. Fruits **35**: 633–638.

Arias Reveron, J.M. 1990. Notes on natural enemies attacking *Lepidosaphes* species (Homoptera: Diaspididae) associated with citrus in Costa Rica. Entomophaga **35**: 301–303.

Azim, A. 1963. *Aphytis cylindratus* Compere (Hymenoptera, Aphelinidae), an effective parasite of *Pseudaonidia duplex* Cockerell. Mushi **37**: 53–63.

Beingolea G., O. 1969. Biological control of citrus pests in Peru. Proc. 1st Internat. Citrus Symp. (Riverside, CA 1968) **2**: 827–838.

Beingolea G., O. 1977. Culmina con exito proyecto de control biologico de la quereza redonda de los citricos, *Selenaspidus articulatus* Morgan, en el Peru. Noticiero Entomol. Soc. Entomol. del Perú. Ano 1, No. 1.

Beingolea G., O. 1989. Rol del control biologico en manejo de plagas de los cultivos mas importante de la Costa Central y Sur del Peru. Fundeagro: Estrategias para el desarrollo de la investigacion Agropecuaria en la Costa Central y Sur del Perú. Sem-Taller, Arequipa, 25–26 mayo, pp. 121–252.

Ceballos, M. and M. Hernandez. 1988. *Aphytis holoxanthus* DeBach (Hymenoptera: Aphelinidae) nuevo bioregulador de *Chrysomphalus aonidum* L. (Homoptera: Dispididae). Rev. Prot. Veg. **3**: 269–270.

Compere, H. 1955. A systematic study of the genus *Aphytis* Howard (Hymenoptera, Aphelinidae) with descriptions of new species. Univ. Calif. Publ. Entomol. **10**: 271–319.

Cock, M.J.W. (Ed.) 1985. *A Review of Biological Control of Pests in the Commonwealth Caribbean and Bermuda up to 1982.* Comm. Inst. Biol. Contr. Tech. Commun. 9, 218 pp.

Crouzel, I.S. de. 1973. Estudios sobre control biológico de cochinillas Diaspididae que atacan cítricos en la Republica Argentina. INTA IDIA **304**: 15–39, 3 pl.

Crouzel, I.S. de and E.G. Merluzzi. 1980. Observaciones biológicas sobre el parásito *Aphytis* prox. *lingnanensis* Compere (Hym. Aphelinidae) y su huesped *Unaspis citri* (Cosmtock) (Hom. Diaspididae). Rev. Soc. Entomol. Argentina **39**: 89–100.

Crouzel, I.S. de, H.G. Bimboni, M.L. Zanelli and E.N. Botto. 1973. Lucha biologica conra la "cochinilla roja australiana" *Aonidiella aurantii* (Maskell) (Hom. Diaspididae) en cítricos. I. Revision general. II. Liberación de parásitos y ensayo de evaluación a campo de *Aphytis melinus* DeBach (Hym. Aphelinidae) en la Republica Argentina. INTA RIA, Serie 5 Pat. Veg. **10**: 251–318.

Crouzel, I.S. de, E.N. Botto, M.L. Zanelli and A. Vetrano. 1979. Ensayo de control biológico contra la "cochinilla roja australiana" *Aonidiella aurantii* (Maskell) en el Establecimento "Aña-cuá" en San Roque, Corrientes. Informe preliminar. Rev. Soc. Entomol. Argentina **38**: 47–62.

DeBach, P. (Ed.) 1964. *Biological Control of Insect Pests and Weeds.* Reinhold, New York, 844 pp.

DeBach, P. 1984. *Aphytis simmondsiae* n. sp. (Hymenoptera: Aphelinidae), a parasite of jojoba scale, *Diaspis simmondsiae* (Homoptera: Diaspididae). Folia Entomol. Mex. **60**: 103–112.

DeBach, P. and G. Gordh. 1974. A new species of *Aphytis* that attacks important armored scale insects. Entomophaga **19**: 259–265.

DeBach, P. and J. Landi. 1961. The introduced purple scale parasite, *Aphytis lepidosaphes* Compere, and a method of integrating chemical with biological control. Hilgardia **31**: 459–497.

DeBach, P. and D. Rosen. 1976. Armoured scale insects. *In*: Delucchi, V.L. (Ed.), *Studies in Biological Control.* Cambridge University Press, pp. 139–178.

DeBach, P. and D. Rosen. 1991. *Biological Control by Natural Enemies*, 2nd Ed. Cambridge University Press, Cambridge, 440 pp.

de Moraes, L.A.H. and R.F.P. Da Silva. 1987. Indice de parasitismo de *Mytilococcus becki* (Newman, 1869) (Homoptera, Diaspididae) em laranjeira de cultivar Valencia (*Citrus sinensis* L. Osbeck) no municipio de Taquari, RS. Agron. Sulriograndensis **23**: 41–47.

De Santis, L. 1935. Un himenóptero parásito de la cochinilla roja de los citrus nuevo para la fauna argentina (*Aphytis chrysomphali* G. Mercet). Rev. Fac. Agron. La Plata **20**: 262–271.

De Santis, L. 1948a. Estudio monografico de los Afelínidos de la Republica Argentina (Hymenoptera, Chalcidoidea). Rev. Mus. La Plata, n.s., Zool. **5**: 23–280.

De Santis, L. 1948b. Adiciones a la fauna argentina de Afelínidos (Hymenoptera, Chalcidoidea). Notas Mus. La PLata, Zool. **13**: 43–48.

De Santis, L. 1967. *Catálogo de los Himenópteros Argentinos de la Serie Parasitica Incluyendo Bethyloidea.* Publ. Comis. Invest. Cie. Prov. Bs. Aires, 337 pp.

De Santis, L. 1979. *Catálogo de los Himenópteros Calcidoideos de America al Sur de los Estados Unidos.* Publ. Esp. Comis. Invest. Cie. Prov. Bs. Aires, 488 pp.

De Santis, L. 1980. *Catálogo de los Himenópteros Brasilenos de la Serie Parasitica Incluyendo Bethyloidea.* Publ. Univ. Fed. Paraná Curitiba, 395 pp.

De Santis, L. 1981. Catálogo de los Himenópteros Calcidoideos de America al Sur de los Estados Unidos. Primer Suplemento. Rev. Per. Entomol. **24**: 1–38.

De Santis, L. 1989. Catálogo de los Himenópteros Calcidoideos de America al Sur de los Estados Unidos. Segundo Suplemento. Acta Entomol. Chilena **15**: 9–90.

Ebeling, W. 1957. Dos informes sobre problemas insectiles de los citricos en Cañete, Perú, Agosto de 1957. Inf. Mimeogr. Est. Exp. Agr. de Cañete.

Fidalgo, A.P. 1983. Los parasitoides y predatores de *Melanaspis paulistus* Hempel (Hom. Coccoidea) en el Norte argentino. Acta Zool. Lilloana **37**: 119–125.

González, R.H. 1981. Biología, ecología y control de la escama de San Jose en Chile. Publ. Cie. Agric. Univ. Chile 9, 64 pp.

González, R.H. and S. Rojas. 1966. Estudio analitico de control biologico de plagas agricolas. Agriculura Tecnica (Chile) **26**: 133–147.

Hernandez Ramirez, J. 1991. El Control Biologico en Costa Rica. Min. Agr. y Ganadería, Direc. Inv. y Extensión Agr. San José, Costa Rica 7, pp.

Jerez Ruiz, E. 1983. *Aphytis lingnanensis* Compere (Hymenoptera, Aphelinidae) nuevo parásito de *Unaspis citri* (Comstock) (Homoptera, Diaspididae) en Cuba. Centro Agrícola **10**: 83–91.

Jiménez J.E. 1961. Resúmen de los trabajos de control biológico que se efectúan en México para el combate de las plagas agrícolas. Fitofilo (México) **32**: 9–15.

Laing, J.E. and J. Hamai. 1976. Biological control of insect pests and weeds by imported parasites, predators and pathogens. *In*: Huffaker, C.B. and P.S. Messenger (Eds), *Theory and Practice of Biological Control.* Academic Press, New York, pp. 685–743.

Liotta, G. 1980. Rapporti tra *Aphytis chilensis* (How.) e *Aspidiotiphagus citrinus* (Craw) (Hym. Aphelinidae) sull'ospite *Aspidiotus nerii* Bouché (Hom. Diaspididae). Fruits **35**: 695–699.

Maltby, H.L., E. Jiménez-Jiménez and P. DeBach. 1968. Biological control of armored scale insects in Mexico. J. Econ. Entomol. **61**: 1086–1088.

Matta, V.A. 1979. Enemigos naturales de las conchuelas blancas del olivo en el Valle de Azapa, Arica, Chile. Idesia **5**: 231–242.

Matta, V.A. and O.N. Hichins. 1979. Nuevas identificaciones de entomofagos (Hym. Chalcidoidea) para el Norte de Chile. Idesia **5**: 287–288.

McClain, D.C., G.C. Rock and J.B. Woolley. 1990. Influence of trap color and San Jose scale (Homopera: Diaspididae) pheromone on sticky trap catches of 10 aphelinid parasitoids (Hymenoptera). Environ. Entomol. **19**: 926–931.

Prado, E. 1991. Artropódos y sus enemigos naturales asociados a plantas cultivadas en Chile. Bol. Técn. Inst. Invest. Agrop. (169): 118.

Rojas P.S. 1987. Plagas de los cítricos y control con enemigos naturales. Un enfoque basado en la experiencia personal. Invest. y Progr. Agrop. La Platina No. 44: 25–30. INIA, Chile.

Rosen, D. and P. DeBach. 1979. *Species of* Aphytis *of the World (Hymenoptera: Aphelinidae)*. Israel University Press, Jerusalem and W. Junk, The Hague, 801 pp.

Schauff, M. A. 1985. Collection notes. Slide mounting of types. Chalcid Forum **5**: 4–5.

Terán, A.L., M L.C. de Manes, S. Glencross, H. Lazaro and R. Alvarez. 1985a. Parasitoides primarios y secundarios de la cochinilla roja australiana, *Aonidiella aurantii* (Mask.) (Homoptera: Coccoidea, Diaspididae) en plantaciones citricas de Tucumán, República Argentina. CIRPON Rev. Invest. **3** (3–4): 7–14.

Terán, A.L., M.L.C. de Manes, S. Glencross, H. Lazaro and R. Alvarez. 1985b. Himenópteros parasitoides primarios y secundarios de Diaspididos, excepto *Aonidiella aurantii* (Mask.) (Insecta; Homoptera: Coccoidea) en los cítricos de Tucumán (República Argentina). CIRPON Rev. Invest. **3** (3–4): 25–33.

Townsend, C.H.T. 1912. The work in Peru against the white scale of cotton. J. Econ. Entomol. **5**: 256–263.

Vargas, M.R. 1987. Control integrado de escama de San Jose. Invest. y Progr. Agrop., La Platina No. 44: 48. INIA, Chile.

Woolley, J.B. and H.W. Browning. 1987. Morphometric analysis of uniparental *Aphytis* from chaff scale, *Parlatoria pergandii* Comstock, on Texas Citrus (Hymenoptera: Aphelinidae; Homoptera: Diaspididae). Proc. Entomol. Soc. Wash. **89**: 77–94.

Zuñiga, E. 1991. Response to a questionnaire on biological control. FAO Regional Office for Latin America and the Caribbean. Santiago, Chile.