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ARTHROPODS OCCURRING ON SWEET WHITE LUPIN AND NATIVE LUPINS IN SOUTHEASTERN WASHINGTON

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Abstract.—The major pests of white lupin, *Lupinus albus* L., in eastern Washington were *Lygus* spp., *Delia* spp., *Spodoptera praefica* (Grote), and *Mamestra configurata* Walker. On native lupins (*L. leucophyllus* Douglas, *L. polyphyllus* Lindl. and *L. sulfureus* Douglas), the most destructive insects were *Tychius lineelus* LeConte and *Glaucopsyche lygdamus* (Doubleday). *Pima albocostalialis* (Hulst) was a primary pest of both native and white lupin as it bored into pods and fed on seeds. Native lupins develop, on average, earlier in the year than white lupin. Pests associated with these native lupins are often univoltine and closely synchronized with their host plant. Consequently, these pests are separated temporarily from the development of white lupin. In contrast, pests associated with white lupin are typically multivoltine and are more generalized with regard to their food source requirement. Because of these factors, pests of native lupin species, with the exception of *P. albocostalialis,* do not contribute greatly to the pest complex of white lupins.

Key Words.—Insecta, white lupin, *Lupinus albus,* Washington

A survey of arthropods collected from native and commercially grown lupins in the Pacific Northwest has not been previously reported. Accounts of insect visitors to low alkaloid, commercially grown lupins have often been general (Frey 1983; Gladstones 1970; Myhre 1988; Nelson et al. 1983a, b); dealt with one or a few species (Cohen & Mackauer 1986, 1987; Guthrie 1954; Knowlton 1945; Nel 1961); or have related to a specific aspect of the plant's biology such as pollination (Bohart 1960, Forbes et al. 1971, Leuck et al. 1968, Williams 1987). Studies of arthropods associated with native *Lupinus* spp. (Breedlove & Ehrlich 1968, Knowlton 1945, Rockwood 1951) are either general or specific to one lupin or arthropod species. This paucity of information may, in part, be due to the uniqueness of lupins as a crop plant and to the rarity of cases where their associated insects have reached damaging levels.

Cereal farmers in the Palouse region of eastern Washington have, in recent years, experimentally grown white lupin, *Lupinus albus* L., as a rotational crop to replace traditional rotations of peas and lentils (Goldstein 1986). However, damaging arthropods and an arthropod borne bacterial disease were apparent in Washington almost from the outset and after three seasons accounted for almost total seed crop loss (Tanigoshi & Babcock 1989). In order to successfully integrate *L. albus* into a dryland cropping program in the Palouse, knowledge about potential pest complexes, reservoirs of those populations, and timing of their occurrence on the host plants is needed.

We report here the arthropods encountered on *L. albus* and on native *Lupinus* spp. that may serve as reservoirs of pest species.

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Materials and Methods

Experimental plots of *L. albus,* variety 'Ultra', were established in 1985 at the Washington State University Spillman Agronomy Farm, Pullman, Whitman Co.; in 1986 near Waitsburg, Walla Walla Co.; 21 km N of Davenport, Lincoln Co. and the Spillman site; in 1987 and 1988 at the Beulah Wilson Wilke Research and Extension Farm, Davenport, Lincoln Co., and at the Waitsburg site. Native lupins from near Pullman and Sprague, Whitman Co., Waitsburg, Walla Walla Co., and Central Ferry, Garfield Co., were surveyed for arthropods on a regular basis during 1986, 1987, and 1988. A survey visit was made to the Hanford Arid Lands Ecology Reserve, Benton Co. in 1988. Samples of native lupin species were identified by personnel at the Ownby Herbarium at Washington State University.

Records of arthropod species present, their damage, and relative abundance on lupin were made throughout the growing season (Table 1). Voucher specimens are deposited in the James Entomological Collection at Washington State University. Observations on the phenology of native and white lupin species were made to correlate arthropod presence with food resources (i.e., pods, stems, flowers). Figure 1 shows the phenological separation between perennial native lupins and annual, spring cultivated white lupin.

White lupin plots were primarily sampled with a standard 38 cm diameter sweep net. Aerial nets, Malaise traps and whole plant samples were also used to sample for arthropods. In native lupin plots both aerial and sweep nets were used. However, to assure that only insects actually on lupins were collected, many arthropod species were aspirated directly from the plants. Whole plants were collected throughout the season and arthropods extracted in the laboratory. When immature forms were collected, an attempt was made to rear representatives to adulthood.

Results and Discussion

Very few non-insect arthropods were collected from either *L. albus* or the native lupins. However, low populations of the twospotted spider mite, *Tetranychus urticae* Koch, developed on the leaves of *L. albus* in mid to late July. At this time, leaf abscission is occurring through the normal maturation of the crop and the twospotted spider mite does not achieve pest status. This phytophagous mite was never observed on native lupin species. Occasionally, predaceous prostigmatid mites were observed at very low densities on native lupins. Spiders of the family Thomisidae and Salticidae were common on native lupins and were occasionally collected from *L. albus.*

The western flower thrips, *Frankliniella occidentalis* (Pergande) was common in all commercial plots and native lupin plots during flowering. Less frequently encountered was *Odontothrips loti* (Haliday). Population numbers peaked around 15 Jun–1 Jul and corresponded with peak *L. albus* bloom. The anthocorid, *Orius tristicolor* White, which is a predator of thrips became abundant during this same time period. Following bloom, both thrips species declined rapidly. No damage was attributed to feeding by *F. occidentalis.* Forbes et al. (1971) showed that *Frankliniella* spp. could cause male sterility by destroying pollen. The destruction of male gametes within a flower might reduce yield since *L. albus* is primarily self-fertilized. Henson & Stephens (1958) showed that *Frankliniella tritici* (Fitch)

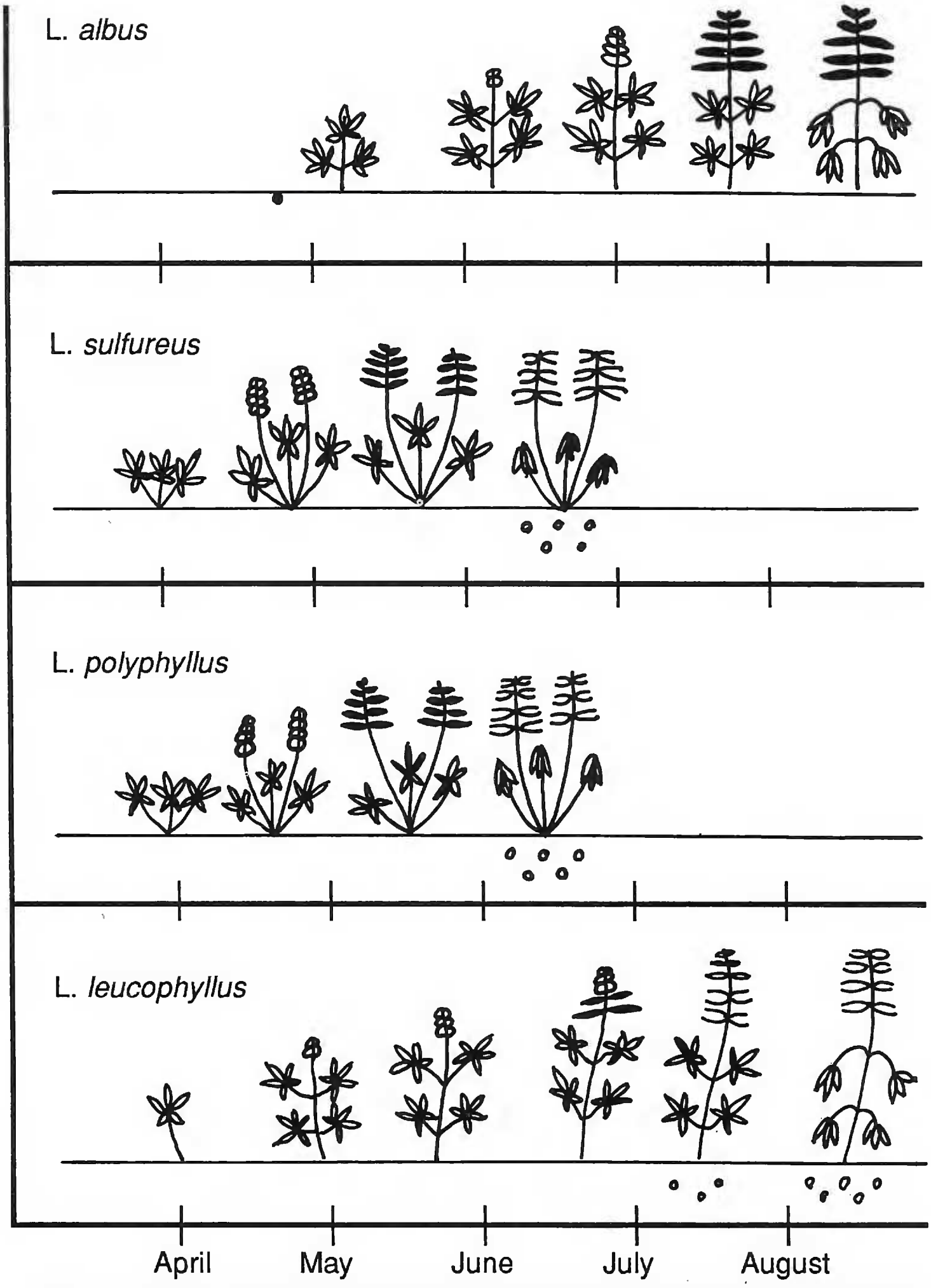

Figure 1. Seasonal phenology of *Lupinus albus* and native lupin species near Waitsburg, Washington, 1988.

and *Dendrothrips bispinosa* Bagnall were responsible for stunting, poor bloom and leaf drop of *Lupinus angustifolius*. L.

Homoptera were represented in our plots by cicadellids, membracids, cercopids, and aphids. Of these groups, the cicadellids were occasionally common on *L.*

Table 1. Arthropods associated with *L. albus* and native lupin species.

	Native lupins	White lupin
Acari		
Tetranychidae		
Tetranychus urticae Koch	N[a]	U
Araneae		
Thomisidae		
Misumena vatia (Clerck)	U	C
Xysticus sp.	U	U
Misumenops sp.	U	U
Insecta		
Orthoptera		
Gryllidae		
Oecanthus quadripunctatus (Beutenmuller)	N	U
Acrididae		
Melanoplus bivivittatus (Say)	N	R
Dissosteira carolina (L.)	N	R
Thysanoptera		
Thripidae		
Frankliniella occidentalis (Pergande)	C	C
Odonotothrips loti (Haliday)	U	U
Hemiptera		
Anthocoridae		
Orius tristicolor White	C	C
Miridae		
Chlammydatus sp.	A	C
Plagiognathus sp.	C	U
Labops hesperius Uhler	C	N
Leptopterna dolabrata (L.)	C	N
Lygus hesperus Knight	R	A
L. desertinus Knight	R	U
L. elysis Van Duzee	R	C
L. lineolaris de Beauvois	R	A
Nabidae		
Nabis alternatus Parshly	C	A
Lygaeidae		
Lygaeus kalmii Stål	R	R
Geocorus bullatus Say	C	A
Berytidae		
Neides muticus Say	R	R
Alydidae		
Alydus calaratus (L.)	U	U
Megalotomus quinquespinosus (Say)	R	N
Tollius curtulus (Stål)	N	U
Pentatomidae		
Chlorochroa uhleri (Stål)	R	A
C. granulosa (Uhler)	R	C
Thynata pallidovirens setosa Ruckes	R	U

Table 1. Continued.

	Native lupins	White lupin
Codophila remota Hovarth	R	R
Euschistus variolaris (de Beauvois)	N	R
Holcostethus limbolarius (Stål)	N	R
Homoptera		
Membracidae		
Tortristilus inermis Fabricus	U	U
Aphididae		
Acyrthosiphon pisum (Harris)	N	R
Macrosiphum albifrons Essig	N	U
Aphis lupini (Gillette & Palmer)	U	N
Neuroptera		
Raphididae		
Agulla sp.	R	R
Hemerobiidae	R	U
Chrysopidae		
Chrysopa plorabunda Fitch	R	U
C. oculata Say	R	U
Coleoptera		
Scarabaeidae		
Euphora inda L.	R	R
Elateridae		
Ctenicera glauca (Germar)	U	R
C. lobata (Eschscholtz)	R	R
Limonius infuscata Motschulsky	N	R
Aeolus dorsalis Say	N	R
Cardiophorus montanus Bland	R	R
Dermestidae		
Cryptorhopalum uteanum Casey	N	R
Melyridae		
Collops versatilis Fall	R	R
C. hirtellus LeConte	U	C
Amecocerus glabratus Hatch	U	N
Coccinellidae		
Hippodamia apicolis Casey	N	R
H. caseyi John	N	R
H. sinulata Mulsant	N	R
H. tredecimpuctata L.	N	R
H. convergens Guerin-Meneville	U	A
Coccinella transversagutatta Brown	U	C
C. novemnotata Herbst	N	R
C. trifaciata L.	R	U
Scymnus marginicollis Mannerheim	N	R
Hyperaspis dissoluta Crotch	N	R
Meloidae		
Epicauta puncticollis (Mannerheim)	U	U

Table 1. Continued.

	Native lupins	White lupin
E. normalis Werner	R	R
Lytta cyanipennis LeConte	U	N
Cerambycidae		
Xestopleura crassipes LeConte	R	R
Stenocorus vestitus Haldeman	R	R
Bruchidae		
Acanthoscelides submuticus (Sharp)	R	N
Chrysomelidae		
Psylliodes punctulata Melsneimer	N	R
Leptinotarsus decimlineatus (Say)	N	R
Phyllotreta lewsii (Crotch)	N	R
Monoxia angularis (LeConte)	R	U
Curculionidae		
Sitona lineatus L.	U	C
Tychius lineelus LeConte	A	N
Otiorhynchus ovatus (L.)	R	N
Ceutorhynchus rapae Gryllenhal	N	R
Lepidoptera		
Pyralidae		
Pima albocostalialis (Hulst)	C	C
Etiella zinckenella (Trietsche)	U	U
Psychidae		
Apterona helicus (Siebold)	R	N
Gelechiidae		
Filatima sp.	C	N
Arctiidae		
Estigmene acrea (Drury)	N	R
Noctuidae		
Spodoptera praefica (Grote)	R	C
Mamestra configurata Walker	R	C
Schinia sveta (Grote)	R	U
Lycaenidae		
Strymon melinus Heubner	R	U
Glaucopsyche lygdamus (Doubleday)	A	N
Nymphalidae		
Autographa californica Speyer	N	U
Diptera		
Cecidomyiidae		
Dasyneura sp.	U	N
Chloropidae		
Chloropsica glabra (Meigen)	U	C
Anthomyiidae		
Delia platura Meigen	C	C
D. lupini Coquillett	C	C
Adia cincerella (Fallen)	N	R

Table 1. Continued.

	Native lupins	White lupin
Agromyzidae	C	C
Sarcophagidae		
Wohlfahrtia vigil (Walker)	N	U
Hymenoptera		
Braconidae		
Crassomicrodus sp.	R	N
Bracon prob. *tychii* (Muesbeck)	R	N
Pteromalidae		
Habrocytus sp.	U	N
Perilampidae		
Perilampus sp.	U	U
Chrysolampus schwarzi Crawford	U	N
Eurytomidae		
Eurytoma sp.	U	N
Chalcididae		
Brachymeria sp.	N	U
Spilochalcis sp.	N	U
Vespidae		
Polistes fuscatus aurifer Sassure	N	R
Apidae		
Bombus sp.	U	U
Colletidae		
Hylaeus sp.	N	R
Halictidae		
Halictus spp.	N	R
Dialictus spp.	N	R
Andrenidae		
Andrena spp.	N	R
Megachilidae		
Synhalonia sp.	U	U

Key to insect abundance: a = Abundant at all locations for a large part of the season; C = Common at all locations but for a brief period of time; U = Uncommon. May be sporadically common but usually not collected at all locations on the same date; R = Rare. Found at very low densities throughout the season and may be found only at one location. N = Not encountered at any location.

albus early in the season prior to flowering. No damage was attributable to leafhoppers although they were often abundant.

The aphid *Macrosiphum albifrons* Essig was found on *L. albus* in highly clumped aggregations. These founder clumps did not disseminate into the remainder of the field but remained localized within several square meters of the initial infestation. This behavior was similar to that reported by Cohen & Mackauer (1986) for *M. albifrons*. Although *M. albifrons* was never found during this study on any of the native lupin species, *Aphis lupini* Gillette & Palmer was encountered on *Lupinus sulphureus* Douglas and *L. leucophyllus* Douglas at several locations but

never on *L. albus.* Rockwood (1951) and Knowlton (1945) reported *M. albifrons* commonly infesting *L. polyphyllus* Lindl. *Macrosiphum albifrons* also infested *L. polyphyllus* and *L. leucophyllus* in the greenhouse. *Aphis lupini* was transferred to *L. albus* in the laboratory and was able to survive for several weeks, however, the population did not increase. *Aphis lupini* was first observed on native lupin species around middle to late May and alate forms were typically not common until mid June when native lupins are senescing.

Hemipterans are well represented on both white lupin and native lupin species, however, the assemblage of species found on *L. albus* and native lupins was substantially different. The lygus bug complex of *Lygus hesperus* Knight, *L. desertinus* Knight, *L. elysis* Van Duzee, and *L. lineolaris* Palisot de Beauvois was found in abundance on *L. albus,* but these bugs were infrequently found on native lupins. Although lists of *Lygus* spp. hosts (Domek & Scott 1985, Fye 1980) have no lupins listed, Horning & Barr (1970) collected *L. hesperus* from *Lupinus* spp. in southern Idaho. *Lygus* spp. first appeared on *L. albus* around 1 Jun, but did not become common until the first week of July. At this time there was an influx of *Lygus* from maturing and senescing weed hosts. Simultaneously, peak flowering and first pod set in white lupin makes it susceptible to *Lygus* feeding injury. This abundance, of prime food resource, affects a dramatic population increase that by 15 Jul reached over 150 adult *Lygus* and 400 nymphs per five, 180 degree sweeps. At levels considerably below these peaks, severe damage to young pods and flowers is produced and leads to significant yield reduction (Tanigoshi & Babcock 1989). As plants mature, *Lygus* numbers will decrease, but remain at low densities until harvest.

Native lupins are fed on by an abundance of bugs other than species of *Lygus. Lupinus polyphyllus* and *L. sulphureus* are not utilized to a great extent because they mature before hemipterans become abundant. Later maturing *L. leucophyllus* are hosts for the mirids *Labops hesperius* Uhler, *Plagiognathus* sp., *Chlammydatus* sp. and *Leptopterna dolabrata* (L.). These mirids were common on *L. leucophyllus* as adults at the end of May and remained until the plants dry out. Little damage was apparent from their feeding activity. Of the mirids occurring on native lupins, only *Chlamydatus* sp. was collected from *L. albus* with any regularity. *Nabis alternatus* Parshly and *Geocorus bullatus* Say were often found feeding on small arthropods such as hemipteran nymphs on *L. albus* and native lupins.

The alydid, *Alydus calaratus* (L.), was often found on *L. leucophyllus* where it was observed feeding on pods. This bug was occasionally found on white lupin along with another alydid *Tollius curtulus* (Stål).

Pentatomids were abundant on *L. albus* but uncommon on native lupins. The most common of these were the *Chlorochroa* spp. which appeared in the field around mid to late July when pods were maturing. Like *Lygus* spp. these pentatomids migrated into lupins from drying cereal crops and weeds. The pentatomids fed on pods but did not cause extensive damage because their densities remained low and they fed on mature, less easily damaged pods.

Chrysopid and hemerobiid adults were common on *L. albus* but immatures were rarely seen. The raphidiid *Agulla* sp. was often found pupating in dead stems of *L. leucophyllus.*

The most common plant feeding beetle was the weevil *Tychius lineelus* LeConte which was collected from *L. leucophyllus, L. sulphureus* and *L. polyphyllus.* This

univoltine weevil feeds on seeds inside the pod and mature larvae drop to the ground to pupate and overwinter. Clarke (1971) reared the weevil from *Lupinus* spp. in Utah and described its biology. In some areas, up to 75% of the pods hosted weevil larvae. *Tychius lineelus* was not collected from white lupin due to its temporal synchrony with earlier developing native lupin hosts.

Several species of immature wireworms were collected from the roots of young *L. albus* seedlings. Adult wireworms were common on flowers of *L. albus* and native lupins, with neither life stage attaining economic levels.

The melyrid, *Collops hirtellus* LeConte, was common on *L. albus* through June and July with populations peaking around the middle of June. These beetles moved into white lupin from maturing wheat. Average control densities of up to 10 *C. hirtellus* per five, 180 degree sweeps occurred at the Waitsburg site. These beetles were rarely collected on native lupins because these plants had typically senesced by this time. Another melyrid, *Amecocerus glabratus* Hatch, was common on native lupins at the Hanford ALE reserve on 9 May 1988. This species is probably a flower feeder, as no feeding damage was apparent.

Adult coccinellid beetles were common on native lupins in May and early June, and peaked around the third week of July on *L. albus*. The ladybird beetles, found on native lupins, were overwintering adults while those on *L. albus* had typically migrated from drying cereal crops where they had developed on cereal aphids. The majority of ladybird beetles were *Hippodamia convergens* Guerin-Meneville with *Coccinella transversogutatta* Brown second in abundance. Other ladybird species, together, comprised a small fraction of the total. On white lupins the coccinellid fauna attained densities of up to 90 adults per five sweeps.

Blister beetles, *Epicauta* spp., were common feeders on lupin flowers. Some damage was attributable to this feeding; these beetles rarely became abundant enough to reduce pod set. *Lytta cyanipennis* LeConte occurred toward the end of May and fed on flowers of the native lupins.

The pea leaf weevil, *Sitona lineatus* L., was present on *L. albus* throughout the season and may scallop leaves. However, this damage seemed to cause little reduction in plant vigor. Farrar & Anderson (1953) described the feeding damage of *S. explita* Say larvae on *L. angustifolius* root nodules in South Carolina. Rockwood (1951) also described similar feeding behavior of larval *S. californicus* Fahr. Neither of these weevils were recovered from lupins in this survey.

Lepidopterans are responsible for a large amount of pod and plant damage. Many of the species involved appear to be host specific to native lupins. An exception to this is *Pima albocostalialis* Hulst, a pyralid whose larvae bore into pods and feed on developing seeds. This species appears to be univoltine and is synchronized closely with the phenology of native lupins. Because of its mobility, *P. albocostalialis* will infest *L. albus* and remain at low population levels. Also occurring on both white and native lupins were *Spodoptera praefica* (Grote) and *Mamestra configurata* Walker. These noctuids feed on racemes and young pods of white lupins and can produce large open wounds in more mature pods. *Schinia sveta* (Grote), another noctuid, was an occasional visitor to white and native lupins where their larvae fed on flowers and young pods.

The lycaenid, *Strymon melinus* Heubner, was occasionally found on *L. albus* and its larvae fed on the developing pods and seeds. This species was also observed ovipositing on *L. leucophyllus,* however, larvae were not reared from any native

lupins. *Glaucopsyche lygdamus* (Doubleday) was common on *L. leucophyllus.* Larvae remain on the exterior of the pods and feed on seeds by means of a telescoping prothoracic segment. In some areas the larvae caused considerable damage to developing pods similar to that described by Breedlove & Ehrlich (1968) for *G. lygdamus* feeding on *Lupinus amplus* Greene. Larvae of *G. lygdamus* developed successfully on *L. albus* pods in the laboratory, but they were never found in field plots. This was probably due to the phenological separation of *L. albus* and the univoltine *G. lygdamus.*

Delia lupini Coquillett and *D. platura* Meigen, seedcorn maggots, were common on *L. albus* from the middle of May to the end of June. These anthomyiid flies occasionally oviposited into mature racemes which became stunted and often died as a result of larval feeding. *Delia lupini* was also reared from racemes and stems of *L. polyphyllus.* This maggot was described by Coquillett (1901) from *L. albus* in California and as a pest of blue lupin by Henson & Stephens (1958).

An agromyzid fly was common in May before bloom of *L. albus* where it created small mines in the parenchyma of the leaves. These leafminers were not present at densities high enough to cause visible plant stress. Mines were also common on *L. polyphyllus.*

Wild bees including *Bombus* sp. and *Synhalonia* sp. were commonly observed visiting flowers of both white and native lupins. Leuck et al. (1968) recorded numerous species of bees pollinating *L. angustifolius,* including *Bombus* sp., *Andrena* sp. and *Dialictus* sp. They described the mechanism of pollination for *L. angustifolius* as being similar to that described for peanut flowers (Leuck & Hammons 1965). For exposure of the stigma to occur a pollinator of sufficient mass must alight on the wing petals. Larger bees such as *Bombus* sp. and *Synhalonia* sp. have sufficient mass to expose the stigma. Bohart (1960) listed megachilids as a predominant pollinator of lupins. This agrees with our observations of *Synhalonia* sp. pollinating lupins. Other taxa encountered were *Halictus* spp. and *Diodontus* sp.

In summary, many insect problems may develop on *L. albus.* The pests most frequently encountered (e.g., *Lygus* spp., *S. praefica, M. configurata*) are not prevalent on native lupins or they do not reach damaging levels. Conversely major pests of native lupins (e.g., *T. lineelus* and *G. lygdamus*) do not occur or are not as damaging to white lupin. The pyralid, *P. albocostalialis,* occurs more commonly on native lupins but may reach pest status on *L. albus.* The separation of pest complexes is related to the phenological separation of the two crops and the inherent synchrony of pests attacking native lupins. Often the pests of native lupins can develop on *L. albus* but their life cycles are not synchronized with the appropriate stage of *L. albus.* The pests common on *L. albus* are typically multivoltine and are more generalized with regard to their food resource requirements. These pests utilize *L. albus* at a time when many alternate food sources are drying up.

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