DEPARTMENT OF AGRICULTURE, SOUTH AUSTRALIA

# Agronomy Branch Report

## *Sitona humeralis* Steph. (COLEOPTERA: CURCULIONIDAE) IN SOUTH AUSTRALIA

P.G. Allen,

Senior Research Officer, Entomology

Report No. 35

December, 1971.

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SUMMARY:

*Sitona humeralis* Steph. was first recorded in South Australia in 1966 and is now established in high densities over most of the agricultural areas of the State. *S. humeralis* has the potential to become the most serious pasture pest in South Australia because of defoliation of legume pastures by vast numbers of adults in spring and, probably more importantly, because of the insidious loss of soil fertility in annual medic areas due to the soil-dwelling larvae feeding on nodules.

The spread and significance of this pest in South Australia is described and the general life-history is outlined, though more information is required on its biology. Present insecticidal control of adults is most unsatisfactory and use of biological control, especially introduction of parasites coupled with breeding of resistant or tolerant pasture legume species, appears to offer the most rational approach for control of *S. humeralis* in South Australia.

1. BACKGROUND:

Sitona humeralis Steph. is an introduced weevil which was first recorded in Australia in New South Wales in 1958 (Chadwick 1960). S. humeralis was not found in lucerne in New South Wales during a survey carried out in 1940 and 1941 (Wallace 1941). Identification was made by the Commonwealth Institute of Entomology at the British Museum; Australian material agreed very closely, morphologically, with the strain of S. humeralis found in Algeria (Chadwick 1960). Van Emden (1939) lists S. humeralis from Europe, the Mediterranean, Central Asia and North America. S. humeralis was first recorded in Victoria in 1964 (Anon. 1970).

2. SPREAD AND ESTABLISHMENT OF S. humeralis IN SOUTH AUSTRALIA:

The rate of spread and very high densities of S. humeralis now found in South Australia is a remarkable example of insect establishment. First records of S. humeralis in South Australia were reports of two infestations of 1966 spring-emerged adults at Northfield, November 1966, and Aldinga, June 1967, respectively. At the end of 1967, S. humeralis was known to be well established in the Adelaide Hills, including Kangaroo Island. In 1968, infested areas included Yorke Peninsula and the Mid North. By 1970, S. humeralis was established on Lower Eyre Peninsula and the Upper and Lower South East and in 1971 it was reported from Nundroo, west of Ceduna. S. humeralis has spread into pastoral areas near Hawker and Paratoo. In these drier areas, S. humeralis is probably associated with annual medics growing along the sides of creeks. Distribution of S. humeralis in South Australia is shown in Appendix I.

Highest densities of S. humeralis are found in annual medic growing areas throughout the State; this is especially evident on Yorke and Eyre Peninsulas. Detailed assessments of adult and larval densities have not been made, but evaluation of adult numbers in lucerne in the Adelaide Hills for an insecticidal trial showed an average of 50 adults per square foot (i.e. approximately 2 million per acre) and this density is considered to be less than that found over extensive areas of annual medic country. In a poor quality annual medic pasture (Medicago truncatula and M. polymorpha) near Cummins, larvae were found in densities approaching 200 larvae per square foot and probably averaging nearly 100 larvae per square foot in the paddock.

At first, S. humeralis was considered to be confined to heavier soils, but in 1971 S. humeralis was reported damaging lucerne on the deep sands in the Upper South East, though densities of S. humeralis on sandy soil have not been as high as densities found with heavier soils.

Spread of this weevil would have been impossible to prevent because of its small size and excellent camouflage. This also means that S. humeralis is usually not detected in an area until it is well established. S. humeralis spreads in two ways; by flight from one paddock to another and by transport in machinery and plant material such as hay. The continuous zone of suitable conditions for S. humeralis' survival and reproduction across South Australia would have probably assisted the rapid spread.

3. DAMAGE CAUSED BY S. humeralis:

S. humeralis appears to be a specific legume feeder with a strong preference for annual medics and lucerne. Both adults and larvae cause damage.

3.1 Adult Damage

Adults defoliate legumes; initial feeding causes characteristic "scalloping" of leaf margins and, with heavy infestations, feeding can result in complete defoliation. The most intense damage is caused by newly-emerged adults in spring. Adult feeding can occur in autumn and in mild periods during winter.

Damage can affect lucerne in three ways:-

* Loss of potential grazing or forage from established lucerne during spring, without the lucerne being killed.

* Loss of seed production caused by a reduction in leaf area during spring.

* Loss of plants caused by damage to either spring or autumn sown lucerne, which can result in failure in establishment and necessitate resowing.

Damage can affect annual medics in two ways:-

* Reduced seed-set in spring in "late" districts which may result in poorer pastures in the next year.

* Reduced establishment of annual medics in autumn and early winter, especially in seasons with a "false break".

Adults feed on subterranean clover and strawberry clover, but not in preference to the above medics.

A more obscure, but real, problem with adults is contamination of cereal grain, either in bulk bins at harvest or prior to shipment for export. Detectable presence of insects in grain can jeopardise international trade. Contamination is due to dense "swarms" of actively flying adults found in some areas during spring-early summer. Adults have been found landing on ships 7 miles out to sea.

In areas where S. humeralis occurs in high numbers, it is a household pest because of the very large numbers of adults entering homes in spring and the damage they can do to strawberry clover lawns.

3.2 Larval Damage

Generally, Sitona larvae are subterranean feeders and feed on root nodules, roots or both, depending on the species (Danthanarayana 1967). Damage to nodules by Sitona larvae is of two types. Young first instar larvae burrow into nodules without leaving external signs. When the contents of the nodule are devoured and only the cortex remains, larvae exit through small holes. Older larvae feed from the outside of the nodule and leave an empty shell (Manglitz et al 1963). Danthanarayana (1967) found that Sitona regensteinensis larvae feeding on broom restricted their feeding to cells in the nodule containing bacteria. He questioned whether host specificity of Sitona to legumes is associated with leghaemoglobin.

Intensive winter sampling of lucerne infested with S. cylindricollis, S. humeralis, S. callosa and S. crinita larvae in Central Asia showed that 87.5% of nodules were destroyed by the middle of June (Yakhontov 1935).

Manglitz et al (1963) surveyed large areas of sweet clover in the Northern Great Plains Region of America and found that an overall average of 25% of nodules were damaged by S. cylindricollis. More specific measurements of damage to nodules in the survey were:-

80% damage with 78 larvae per 4 square feet

79% damage with 189 larvae per 4 square feet

20% damage with 30 larvae per 4 square feet

Counts included larvae found in both soil and nodules.

They also noted reductions in the size of sweetclover seedlings which were infested only with larvae of S. cylindricollis.

Damage to nodules, as described above, occurs with S. humeralis larvae in South Australia, especially to annual medics. High densities of larvae in annual medic pastures have damaged almost 100% of nodules and, in some of these, plants were stunted and in very poor condition. Newly hatched S. humeralis larvae burrow almost directly for legume nodules (see 5.3) and feed, but it is considered that older larvae probably feed on roots as well as nodules because very high densities of larvae have been found surviving with a limited supply of nodules.

Effect of this damage on nitrification by medics has not been assessed, but it is considered to be potentially the most important aspect of S. humeralis damage in South Australia.

S. humeralis larval damage may render plants more susceptible to soil-borne plant pathogens. Evidence obtained by Hill et al (1969) indicated that S. hispidula larvae significantly reduced growth of lucerne and that the presence of S. hispidula increased damage caused by fusarium wilt (Fusarium oxysporum). Results with bacteria wilt (Corynebacterium insidiosum were inconclusive. Isolations from roots of S. humeralis damaged M. polymorpha collected from Cummins, September, 1971, contained the pathogens Pythium irregulare, Pythium sp. (possibly graminicolum) and Fusarium solani. The rhizoctonia, Ceratobasodium sp., a parasite of roots, was also isolated. Damage caused by S. humeralis on root nodules was considered to be more important in stunting these plants than the amount of root rotting that was present in this instance. In situations where larval densities are not as high, plant pathogens may have a more significant effect.

There has been no evidence of S. humeralis larval damage to subterranean clovers in South Australia.

## 4. IMPORTANCE OF S. humeralis IN SOUTH AUSTRALIA:

S. humeralis has the potential to become the most serious pasture pest in South Australia, mainly because of damage to nodules caused by very high densities of larvae found in annual medic based pastures; removal of nodules probably results in a decline in soil fertility. There is an estimated 35 to 40 million acres in South Australia which does or could depend on annual medic based pastures for herbage production and fertility build-up. A not unreasonable estimate of the value of nitrogen fixed per year is 50 million dollars and even if the loss due to S. humeralis is only about 20% this is still a very large loss, particularly in view of the insidious nature of a decline in soil fertility. Ability of annual medics to use available soil nitrogen means that deficiency symptoms will not become evident until soil reserves are depleted.

In spring, partial to complete defoliation of annual medics, lucerne and, to a lesser extent, Trifolium species by adult S. humeralis can cause significant forage, plant vigour and seed production losses. Lucerne, though currently grown on only 1.1 million acres, is in more favourable climatic areas (including irrigation) where potential loss of productivity per acre is much greater compared to other legume pasture species. Some 50,000 acres of lucerne are used for seed production and large losses may be caused with spring defoliation by S. humeralis. Spring damage to annual medics is probably most important in terms of seed yields and consequently less dense and less productive pastures in the following years.

Contamination of export cereal grain with adults could pose problems on international markets and has necessitated a close watch on grain being delivered to silos and additional insecticidal treatment of grain loaded on ships during periods of adult flight.

S. humeralis is mainly a pest of lucerne in New South Wales (Anon 1967) and, without extensive areas of annual medic pastures, has not reached the densities or extent of infestation found in South Australia; it is not considered to be a major problem in New South Wales. In Europe and the Near East, species of Sitona are known as pests of leguminous crops (Melamed - Madjar 1966), but in Israel, where there is little use of annual medics in agriculture, they are not considered to cause damage requiring treatment, though Bar-Droma (personal communication 1970) believes that the damage is under-estimated.

## 5. BIOLOGY OF S. humeralis:

All studies on the biology of Sitona species indicate that, in the northern countries of their distribution, the species hibernate, become active in spring, and are active throughout summer. In southern countries, where the winter climate is more suitable for activity, summer is spent in diapause. Termination of diapause varies with the species and its particular host (Melamed-Madjar 1966a).

Life history of S. humeralis in South Australia appears to be different from that described by Anon (1967) for S. humeralis in New South Wales. Factors affecting S. humeralis are not fully understood but the following notes outline what is presently known about S. humeralis in South Australia.

## 5.1 Adults

Adults emerge during October-November and females are sexually immature. In high density areas, flying adults can be seen "swarming" in spring. Reasons for swarming are not understood but swarming occurs with higher temperatures on days with little wind. Newly-emerged adults actively feed if green legumes, mainly lucerne, are present. Effect of spring feeding on adult survival through summer is not understood and feeding appears to be limited in annual medic areas, where the highest densities of S. humeralis occur, because there are limited areas of lucerne and annual medics mainly "dry-off" early. Most feeding occurs in early morning and late afternoon with adults sheltering in cracks in the soil or under vegetable matter at the base of the plants through the day. Adults appear to stop feeding about the end of December.

Adults aestivate during summer months then resume feeding during autumn; feeding may be obvious, also, in warmer periods of winter. Females become sexually mature with formation of the first eggs during April (Allen 1970 unpublished, Reimers 1971 unpublished) and oviposition continues throughout the winter months to mid-November for the last survivors (Allen 1970 unpublished). Food is required for oviposition and females are capable of producing over 1,000 eggs. Adults live for approximately a year and most are dead by the end of October, but a few may survive into November-December. Mortality rate of adults during winter is not known.

## 5.2 Eggs

Eggs are laid singly on the soil surface and time for hatching in moist conditions depends on temperature (14 days at 22°C, 26 days at 15°C, greater than 2 months at 10°C).

5.3 Larvae

Newly hatched larvae bore into the soil and burrow almost directly for legume nodules. This was observed in the laboratory by placing newly hatched larvae on the surface of agar containing nodulated lucerne seedlings (Allen, unpublished). Length of larval period is not known, nor is the number of nodules required for full larval development. *S. hispidula* larvae take 65 days to pupate at 18°C (Newton 1958). The high larval densities supported in annual medic pastures suggest that larvae may feed on material other than nodules, but nodules are apparently preferred. At any time during winter, field populations contain a wide range of larval instars which would be a reflection of the extended oviposition period.

Newton (1958) outlined a method for rearing *S. hispidula* larvae for various research uses which provides useful background information when *S. humeralis* larvae are studied.

5.4 Pupae

Little is known about pupae, but they can be found in the field as early as September.

6. CONTROL OF *S. humeralis*:

6.1 Insecticidal Control

Present insecticidal control methods are directed at adults and are most unsatisfactory since they depend on organic phosphorus insecticides (azinphos-ethyl, fenitrothion, methidathion) which are relatively expensive and provide little residual effect. Treatment of an infested area kills those adults present, but it may not be long before the area is reinfested. Reinfestation is mainly due to masses of adults flying in from outside, untreated areas and, to a lesser extent, to adults emerging from the paddock being treated when treatment is carried out in spring. Adults flying in from outside areas is a very real problem since *S. humeralis* has become established in such high densities over such wide areas of the State. Treatment, which can involve more than one spray application, is only recommended as a palliative control in certain situations, e.g. late spring control in lucerne for seed production where a high value crop is being protected or with seedling lucerne and annual medics where cost of treatment is compared to cost of resowing. Treatment of lucerne for grazing is only recommended where there is an extreme feed shortage and this includes a three week stock withholding period which may be a problem. Treating only the edges of crops may provide some protection.

Insecticidal control of the soil-dwelling larvae in established lucerne or annual medic pastures would be very difficult and generally impractical.

## 6.2 Biological Control

Introduction of parasites coupled with the selection and growing of *S. humeralis* resistant or tolerant strains of medics appears to be the most promising method of controlling or reducing the effect of *S. humeralis* in southern Australia. In some countries *Sitona* species are affected by insect pathogens.

### 6.2.1 Introduction of parasites

Some parasites of *Sitona* species have been studied for release into Canada and North America against the introduced sweetclover weevil, *Sitona cylindricollis* Fahrs. Allen (1971) has reviewed these parasites and results obtained with them. Introduction of parasites probably offers the most rational approach for the control of *S. humeralis* in southern Australia.

### 6.2.2 Plant resistance/tolerance

Breeding plants resistant or tolerant to a particular pest may not necessarily provide the complete answer to a problem, because complete resistance or immunity is not always possible. However, growing plants which offer a degree of resistance to the pest can help to alleviate the problem and assist other control methods to give acceptable control.

Methods have been developed for field (Radcliffe *et al* 1965), laboratory (Hedlin *et al* 1964) and glasshouse (Connin *et al* 1958) evaluation of the degree of resistance or tolerance of different *Melilotus* species to adult *S. cylindricollis*. Assessment of trials were based on visual estimates of percentage of leaf area consumed. Hedlin *et al* (1966) carried out trials measuring the effect of *Melilotus* and *Medicago* species on the longevity and fecundity of adult *S. cylindricollis*. Species causing marked reduction in longevity and fecundity of weevils were considered to be highly resistant; reduction was thought to be due to starvation rather than an antibiotic effect.

Radcliffe et al (1964) found several sources of resistance to S. cylindricollis in Melilotus species and felt additional sources would be located. They considered if plant breeders could overcome the difficult problem of sterility barriers between species, weevil-resistant sweetclovers may become a reality. Further screening of a wide range of accessions of Melilotus species and of species of the closely related genera, Medicago and Trigonella, by Radcliffe et al (1967) provided a number of sources of sweetclover weevil resistance for plant breeding. S. cylindricollis damage to accessions of Melilotus species ranged from an average of 15.3% defoliation to 63.0% defoliation. Several species of Medicago and Trigonella were immune to attack.

Akeson et al (1968) found that S. cylindricollis resistance in Melilotus was influenced by the balance of certain factors in the leaves. The factors were extracted with paper chromatography and, from bioassay tests with adults feeding on sweetclover roots impregnated with the extracts, it was shown that there was a factor, Stimulant A, which stimulated feeding and two factors, Deterrents A and B, which deterred feeding. Depending on the Melilotus species, one or both of the deterrent factors may be found in resistant species. Deterrent B was identified as a nitrate (Akeson et al 1969) and was the predominant factor in young leaves. Deterrent A and Stimulant A assumed increased importance as leaves matured. Evidence indicated that certain sugars were responsible for Stimulant A; identity of Deterrent A was not known.

Mathison (1971 unpublished) screened in the glasshouse over 400 accessions of annual Medicago species for resistance against S. humeralis adults. He found five accessions of M. rugosa from Israel (1), Portugal (3) and Tunisia (1) and one accession of M. scutellata from Russia which showed moderate resistance. Further studies will be carried out with annual Medicago species.

In America, progeny testing of selected clones of lucerne which showed resistance to adult and larval stages of the alfalfa weevil, Hypera postica Gyll., has resulted in commercial production of lucerne varieties which are highly tolerant to H. postica attack (Barnes et al 1970). Both adult and larval stages of H. postica feed above ground. Another programme to develop lucerne varieties resistant to the Egyptian alfalfa weevil, Hypera brunneipennis (Boh.), is now being conducted with apparent success (Lehmann et al 1971).

Kaehne (1971 unpublished) has carried out initial trials with low numbers of plants to test a range of lucerne varieties for tolerance against S. humeralis adults. The lucerne varieties tested were obtained from America and selected because they showed resistance or tolerance to H. postica, the pea aphid, Acyrthosiphon pisum (Harr.) or the spotted aphid, Therioaphis maculatus (Buck.). There was an indication that some varieties were more tolerant to S. humeralis than others, and more detailed mass screening of these tolerant varieties and others will be carried out.

While initial screenings for S. humeralis resistant/ tolerant plants has been restricted to annual and perennial Medicago species, screenings of Trifolium species are envisaged for a comprehensive control programme.

Publications on screening plants for resistance to subterranean Sitona larval feeding were not found, but this is a possibility which may be considered also with S. humeralis on Medicago species, especially annuals.

6.2.3 Pathogens

The cosmopolitan fungal disease, Beauvaria bassiana Bals., attacks Sitona species. Jackson (1920) mentions the fungus as the most important natural enemy of Sitona in Britain. Crow et al (1968) showed that nearly 40% of adult S. hispidula in Missouri were naturally infected with B. bassiana. In the field, mortality of infected weevils due to the fungus is probably reduced by low humidity and temperature. It was not known what affect sublethal infections of B. bassiana may have on the speed of development, longevity or fecundity of S. hispidula.

B. bassiana occurs naturally in South Australia and Reimers (Personal communication) has collected S. humeralis adults from the field infected with a fungus thought to be B. bassiana, but the incidence appears to be very low and is not offering economic control.

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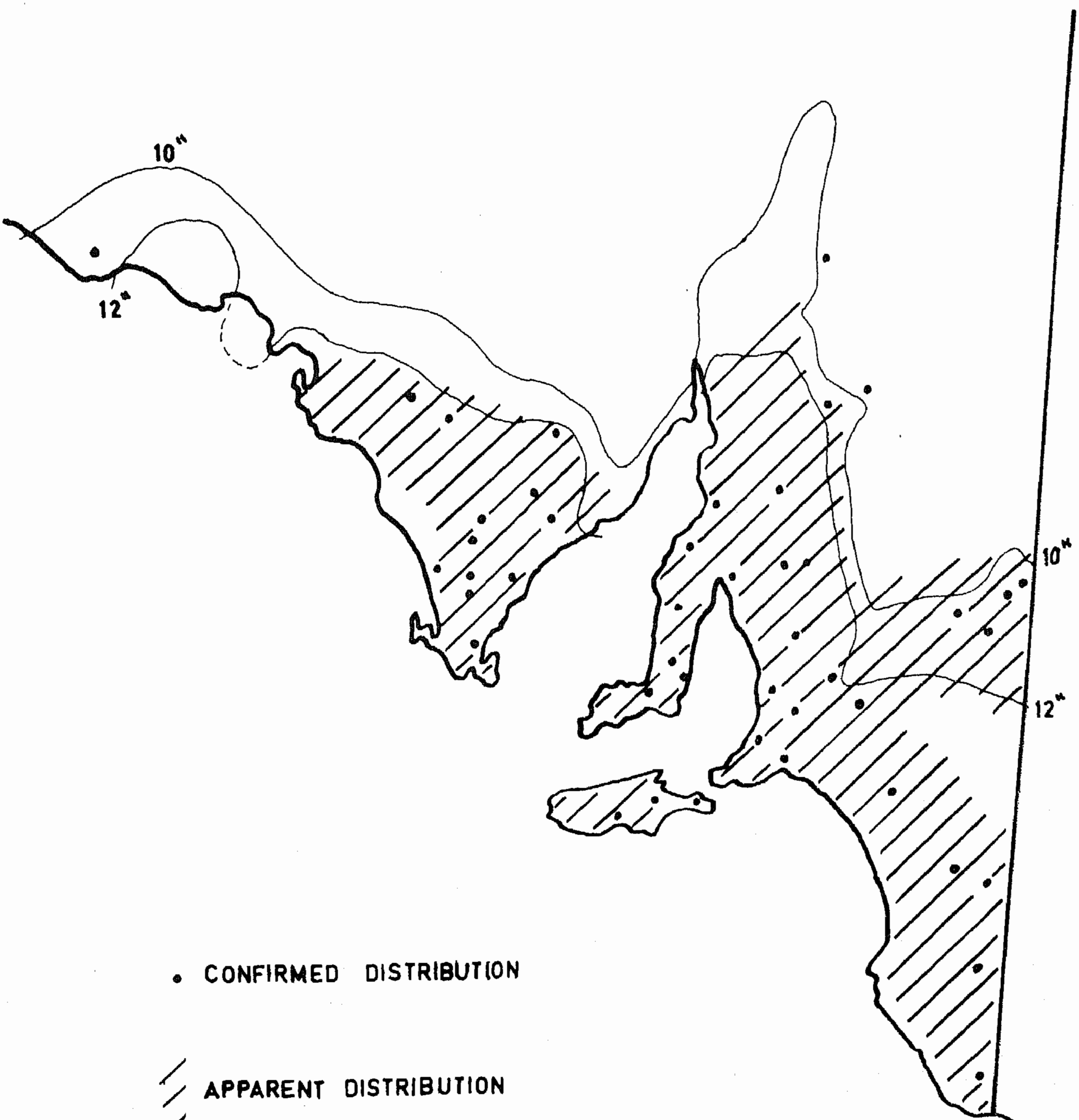
# APPENDIX I - DISTRIBUTION OF *Sitona humeralis* IN SOUTH AUSTRALIA, 1971.

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