

**Geographical distribution of the tortricid moth *Epinotia cedricida*
(Lepidoptera: Tortricidae) within the natural and artificial ranges
of the cedar trees *Cedrus atlantica* and *C. libani***

JEAN-PIERRE FABRE

Institut National de la Recherche Agronomique, Unité de Recherches Forestières Méditerranéennes,
Avenue Antoine Vivaldi, 84000-Avignon, France

**Lepidoptera, Tortricidae, *Epinotia cedricida*, geographical distribution, insect pest, forest trees,
*Cedrus***

Abstract. New data concerning geographical distribution of the tortricid moth *Epinotia cedricida* Diakonoff, a significant insect pest affecting cedars in France, are presented. The species was discovered in Turkey, in two stands of *Cedrus libani*, where it causes considerable damage. The results of reciprocal crosses between Turkish specimens and specimens native to France and North Africa have confirmed the specific identity of the tortricid. On *Cedrus atlantica*, *E. cedricida* is present everywhere in Algeria. In Morocco, it has only been found in three stands of cedar in the Atlas Mountains. With regard to Europe, where the cedar is an introduced species, the tortricid moth has been reported only in France where it has colonized practically all the cedar stands of the Rhône valley, as far as Dijon towards the north, but is not yet present in those of the Garonne valley or the Poitiers area. Some of these data raise the question of the geographical origin of the strain (either north Africa or Turkey) which was introduced into France accidentally.

INTRODUCTION

The tortricid moth *Epinotia cedricida* (Lepidoptera: Tortricidae) is the main defoliating insect in French cedar stands. It was described by Diakonoff (1969) using adult specimens from the south-east of France in 1968 in an Atlas cedar stand of artificial origin located on the mountain mass of the Petit Luberon, Vaucluse (Leclant & Remaudière, 1969). Subsequently, it was found in North Africa: Morocco (Middle Atlas) in 1971 (Fabre, 1976) and in 1976 (Leclant et al., 1977) and in Algeria (Aures) in 1981 (Cavalcaselle, 1985). In the latter case, identification of the tortricid moth was confirmed by Diakonoff.

E. cedricida is monophagous on *Cedrus*, the latter consisting of four species: *C. atlantica* Manetti, indigenous to Morocco and Algeria; *C. libani* A. Richard, indigenous to Lebanon and Turkey; *C. brevifolia* Hooler, indigenous to Cyprus and *C. deodara* G. Don, indigenous to Afghanistan and Pakistan. These species (except *C. brevifolia*) have been quite widely introduced into Europe into parks and gardens as ornamental trees. They are rarely used in reforestation, except in France, where forests of *C. atlantica* cover quite large areas (about 15,000 ha); the oldest stands were planted in the second half of the last century but the great majority were planted during the last twenty or thirty years.

The aim of this article is to present the information concerning the geographical distribution of *E. cedricida*, especially those recorded during investigations in the natural and artificial ranges of *C. atlantica* and in the main part of the natural ranges of *C. libani*.

MATERIAL AND METHODS

In the field, a visual examination was carried out of damage caused to low branches of the trees in the stands visited. Affected boughs were removed and observed under a binocular lens. Caterpillars, thus discovered, were examined thoroughly and raised individually, at temperatures varying from 10 to 15°C, in cylindrical boxes of transparent polystyrene, measuring 40 mm in diameter and 10 mm in height. The bottom of each box was lined with a piece of tissue paper on which a small branch of *C. atlantica*, with needles attached, was placed. The rearing-boxes were put in series into a transparent polystyrene box measuring 260 mm × 135 mm × 65 mm which contained three layers of tissue paper kept humid. Once a week each rearing box was examined and given a fresh supply of needles for food. Pupation occurred on the spot inside a silky cocoon. As soon as the adults emerged, their sex and identity were determined. The genitalia of various male specimens were examined and compared*. Furthermore, in certain cases crossings of specimens of several different geographical origins were made in laboratory conditions, to confirm the results of the morphological examinations. Specimens of both sexes and male genitalia mounted on micro slides were retained and listed.

RESULTS

Biological prospecting in the field

Several investigations took place, first in a large part of the natural range of cedars in the Atlas and Lebanon: in Morocco (4 missions), in Algeria (8 missions), in Turkey (2 missions), in Lebanon (2 missions**) and second, in their European artificial range; France, where most of the reforestation areas more than fifty years old were examined; in Italy (1 mission), and Spain (1 mission). The geographical location of the stands visited (apart from the Italian and Spanish stands) is shown in Fig 1.

DISTRIBUTION IN EUROPE. In France, *E. cedricida* is widespread (Table 1). The cedar stands located in the Rhône valley (in a broad sense), where they extend northward as far as Dijon (Côte-d'Or), and those located in Languedoc are indeed all infested, apart from a few exceptions which remain to be confirmed, these being 4 stands located in the department of Saône-et-Loire, the stand of Vals-les-Bains, in the Ardèche, and the stand of Arles-sur-Tech, in the Pyrénées-Orientales. However, the tortricid does not yet appear to have reached the west of France, since it has been found neither in the valley of the Garonne (Gers), nor in four stands spread out among the departments of the Charente, Vienne and Deux-Sèvres.

The presence of the tortricid moth in Europe, outside France, has never been reported in the literature except in Austria on right banks of the Rhine delta (Huemer & Tarmann, 1993; Huemer, 1994). In Italy, a census revealed the presence of 56 plots of *C. atlantica* found totaling 436 ha. *E. cedricida* was not found on small clumps of cedars in the Florence area, nor in the Forest of Valombrosa. In Spain there are no stands, apart from approximately thirty hectares, about 15 years old in the Gérone area. Observations were made without any positive result on old park trees; there being 6,000 to 7,000 of these in the Madrid area alone.

DISTRIBUTION WITHIN THE NATURAL RANGE OF *C. ATLANTICA*. *E. cedricida* was found in each of the Algerian stands (Table 2). In contrast, its presence was only detected in two stands

* These examinations were carried out by J.P. Chambon (INRA, Laboratoire de Biosystématique de l'Insecte, 78000 Versailles).

** Undertaken by M. Bariteau (INRA, Unité de Recherches Forestières Méditerranéennes, Avignon), in charge of the program "Genetic improvement of cedars".

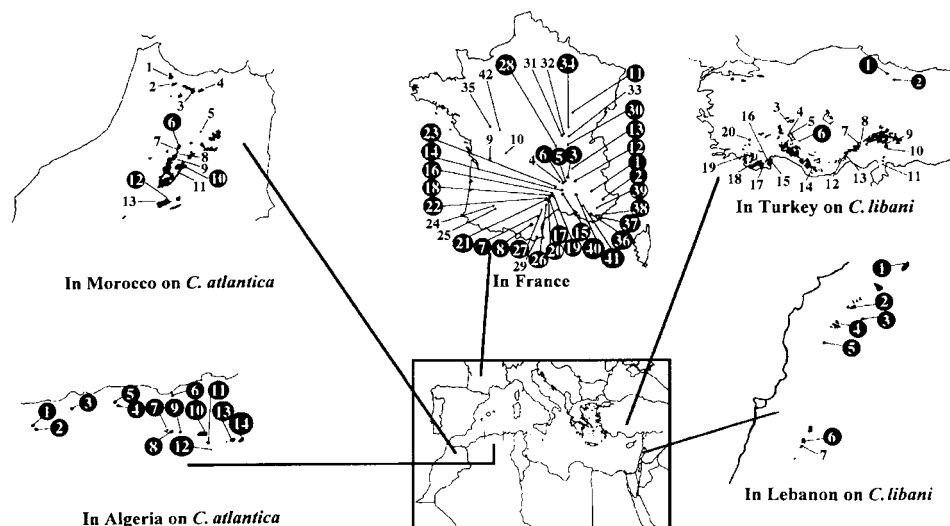


Fig. 1. Natural range (in black) of *C. atlantica* and *C. libani* and known distribution area of *E. cedricida*. The numbers indicate the cedar stands investigated (see Tables 1–6). Those with a black circle refer to the presence of the tortricid moth.

in Morocco (Table 3), situated in Michlifen in the Middle Atlas and Tounfite in the Great Atlas. The fact that the tortricid was not found elsewhere is perhaps an artifact, due to the limited level of its populations. Indeed in Algeria, we observed a decreasing gradient of its ravages from east to west in favour of another species, *E. algeriensis* Chambon, recently described from this country (Chambon et al., 1990) and widespread in Morocco, where we found it in all the cedar stands visited. Thus, the presence of *E. cedricida* in North Africa is confirmed and its distribution classified.

DISTRIBUTION WITHIN THE NATURAL RANGE OF *C. LIBANI*. Systematic investigation of the majority of stands of *C. libani* led to the discovery of *E. cedricida* at Çatalan and Akincilar, two small stands (20 and 70 ha respectively) located in Northern Anatolia on the southern slope of the Pontic Range, in the Amasya area (Table 4). Damage caused by the tortricid was very extensive particularly at Çatalan, where the trees appeared to have suffered from its presence. In addition, a species of tortricid, probably *E. cedricida*, was found in large numbers, at Gökyurt Saglik, another cedar stand located in southern Anatolia near Konya. Unfortunately, the caterpillars collected and raised from this stand failed to produce adults and so the identity of the species is unconfirmed. Furthermore, the other Turkish stands located in the Taurus and the Lebanese stand of Mount Lebanon appear uninfested (Tables 4 and 5), but the extensive damage caused by another tortricid, *Acleris undulana* (Walsingham), perhaps concealed the presence of *E. cedricida*. The last proliferation of *A. undulana* in the western Taurus occurred in 1990–1991 (Alptekin et al., 1997). The stands of the Amasya area, discovered by Savas in 1946 (Selçuk, 1962) are considered to be relictual (Mayer & Aksoy, 1986; Ansin & Küçük, 1990). Indeed, the writings of Theophrastus (between 372–287 BC) and Strabo (58–23 BC) indicated that cedars were widespread in Anatolia (Aksoy & Ozalp, 1990) and pollen analyses confirm this (Beug, 1967).

TABLE 1. Stands of *C. atlantica* visited in France.

Department	Place	No. ¹	Name of stand ²	Altitude (m)	Area (ha)	Age of trees	Date of first investigation	Presence of <i>E. cedricida</i>
Alpes-de-Hte- -Provence	Entrepierrres St-André- -les-Alpes	1	Beaudouze d'Entrepierrres (C.F.)	690	< 1	95	12.81	yes
		2	Le Relais + La Serrière de l'Issole (S.F.)	1100–1650	100	110	12.83 + 12.84	yes
		3	Le Clau (P.F.)	150	< 1	85	12.89	yes
Ardèche	St-Julien-St-Alban	4	Les Bains (P.F.)	250	< 1	115	12.89	
	Vals-les-Bains	5	Mont Redon (P.F.)	650	< 1	115	12.89	yes
	Mirabel	6	Sur Saint-Genest (P.F.)	660	2	65	12.89	yes
Aude	St-Gineys-en-Coirons	7	Marcelly: Pépinière, Espinasse des Soulanes de Nore (S.F.)	550–700	51	65	11.75	yes
	Caunes-Minervois	8	La Bétouse des Corbières occidentales (S.F.)	550–750	78	135	11.75	yes
	Arques	9	Chez M. Dessouche (P.F.)	130	< 1	80	01.90	no
Charente	Fouquebrune	10	Domaine des étangs (P.F.)	270	< 1	50	01.90	no
	Massignac	11	La Trouhaude (P.F.)	330	12	95	12.83	yes
	Dijon	12	Saou (P.F.)	450	1	65	12.83	yes
Côte d'Or	Saou	13	Brandoule (P.F.)	160	4	65	12.83	yes
	Laveyron	14	Camping des Cèdres de Barjac (C.F.)	170	< 1		01.77	yes
	Barjac	15	Vallérargues, Belvezet (C.F.)	300	< 1	65	01.78	yes
Drôme	Vallérargues	16	Perjurade de la Vallée Borgne (S.F.)	400	2	75	03.88	yes
	L'Estrechure	17	Le Mazet (P.F.)	250	2	85	03.88	yes
	Le Vigan	18	La Pieyre-Le Testre (P.F.)	370	2	75	03.88	yes
Gard	Valleraugue	19	La Foux, Taillebourg. de la Vallée Borgne (S.F.)	700	4	65	03.88	yes
	Soudorgues	20	La Foux de la Vis (S.F.)	250	6	85	03.88	yes
	Blandas	21	Le Communal de la Vis (S.F.)	750	4	85	03.88	yes
Lanuejols	Alzon	22	Le chemin de Villaret de l'Aigoual (S.F.)	750–840	2	69	03.88	yes
	Lanuejols	23	Côte de Brin de Mamontet (S.F.)	500–600	4	90	12.89	yes
	Concoules							

Table 1 (continued).

Department	Place	No. ¹	Name of stand ²	Altitude (m)	Area (ha)	Age of trees	Date of first investigation	Presence of <i>E. cedricida</i>
Gers	Aignan	24	Bacquieu d'Armagnac (S.F.)	150	3	55	12.89	no
	Gazax + Bacarisse + Peyrusse Grande	25	Savis d'Armagnac (S.F.)	200–230	10	57	12.89	no
Hérault	La Vacquerie + St-Martin	26	Le Vinas (P.F.)	590	1	85	03.88	yes
Loire	Combes	27	Combes des Ecrivains Anciens Combattants (S.F.)	650	9	64	12.89	yes
	Renaion	28	Chez Chambon (P.F.)	480	8	70	1990	yes
Pyrénées- Orientales	Arles-sur-Tech	29	Mas-d'en-Vignes du Bas Vallespir (S.F.)	800	<1	59	12.89	no
Rhône	St-Lager	30	Bryeslly (P.F.)	430	2	70	03.88	yes
Saône-et-Loire	Ozolles	31	Les Bois Dieu (P.F.)	520	<1	48	03.88	no
	St-Bonnet-de-Joux	32	Les Quatre Chemins (P.F.)	400	<1	58	03.88	no
	Aze	33	Les Grottes d'Aze (P.F. et C.F. d'Aze)	260	1	115	03.88	no
	Givry	34	La Chaume de Givry (C.F.)	350	10	50	04.92	yes
Deux-Sèvres	Pressigny	35	Bois de Chavergnes (P.F.)	140	7	75	01.90	no
Var	Collobrières	36	La Verne Régusse du Dom (S.F.)	480	2	113	01.77	yes
	Saint Maximin	37	Saint Maximin (P.F.)	310	<1	65	01.78	yes
	Flassan-sur-Issole	38	La Rouvière I + La Rouvière II (P.F.)	330	5	95	12.89	yes
	Vérignon	39	Le Moulin à Vent (P.F.)	840	2	95	12.89	yes
Vaucluse	Bedoin + Malaucène	40	Mt Ventoux: (F.C. de Bedoin. + S.F. de Malaucène)	650–1100	900	115	08.69 + 12.89	yes
	Bonnieux, + Lacoste + Ménéberbes	41	Petit Luberon: de Bonnieux, Lacoste et Ménéberbes (C.F.)	600–710	80	115	04.68 ³	yes
Vienne	Montamisé	42	La Roche de Bran (P.F.)	140	2	155	01.90	no

¹ These numbers refer to the map (Fig. 1); ² C.F. – communal forest; S.F. – state forest; P.F. – private forest; ³ Leclant & Remaudière, 1969.

The discovery of *E. cedricida* in Turkey were so unexpected that we attempted reciprocal crosses with the specimens from other geographical areas in order to confirm the specificity of the find.

TABLE 2. Stands of *C. atlantica* visited in Algeria.

Area	Sub-area	No. ¹	Name of stand	Altitude (m)	Dates of investigation	Presence of <i>E. cedricida</i>
Tellien Atlas	Massif of Ouarsenis	1	Ain Antar	1200	12.89	yes
Tellien Atlas	Massif of Ouarsenis	2	Theniet-el-Haad	1350–1500	12.89, 10.91, 11.91	yes
Tellien Atlas	Blidéen Atlas	3	Chr��a	1450, 1550	07.87, 12.89, 11.91	yes
Tellien Atlas	Mountain of Djurdjura	4	Tikjda	1500	06.87, 06.88, 12.89, 07.91	yes
Tellien Atlas	Mountain of Djurdjura	5	Tala Guilef	1600–1800	06.88, 07.91	no
Tellien Atlas	Mountain of Babors	6	Babor	1900–2000	06.87, 06.88, 06.89, 06.91, 11.91	yes
Saharien Atlas	Mountain of Hodna	7	Ouled Tebben	1600	11.91	yes
Saharien Atlas	Mountain of Hodna	8	Bouthaleb	1650	06.88, 11.91	yes
Saharien Atlas	Mountain of Tachirt	9	Guethian	1700–1850	12.90	yes
Saharien Atlas	Massif of Aur��s	10	B��lezma	1700–1900	12.81 ² , 06.87, 06.88, 12.90, 11.91	yes
Saharien Atlas	Massif of Aur��s	11	Sgag	1850	12.90	yes
Saharien Atlas	Massif of Aur��s	12	Taghda	1700	12.90	yes
Saharien Atlas	Massif of Aur��s	13	Le Ch��lia	1700, 1900	12.90	yes
Saharien Atlas	Massif of Aur��s	14	Ouled Yacoub	1450	06.87, 12.90	yes

¹ These numbers refer to the map (Fig. 1).

² Cavalcaselle, 1985

Reciprocal cross experiments between specimens of *E. cedricida* of different origins

Caterpillars collected in Turkey in October 1991 were reared individually in quarantine conditions at the Mediterranean Forestry Research Unit in Avignon. Adults of both sexes were obtained from specimens collected at   atalan and Akincilar. In the summer 1992, some of these specimens were crossed with others originating from cedar stands of the Luberon (Vaucluse, south of France). Four of the eight females used were fertilized and laid eggs, some of which were sterile and other viable (Table 6). The results are practically identical to those obtained from a control couple ‘‘Turkey    Turkey’’ and are roughly equivalent to those found when adults of *E. cedricida* of French origin were reared under laboratory conditions.

The caterpillars resulting from the hybrid eggs ‘‘Turkey    France’’ were placed in individual rearing at 10  C. Adults obtained were crossed during the summer of 1993 with others originating this time from the caterpillars collected in November 1992 in North Africa, and then raised individually, in quarantine conditions, at the Mediterranean Forestry Research Unit in Avignon. Of the four females used, three mated and laid eggs which were mostly viable (Table 6).

TABLE 3. Stands of *C. atlantica* visited in Morocco.

Area	Sub-area	No. ¹	Name of stand ²	Altitude (m)	Dates of investigations	Presence of <i>E. cedricida</i>
Rif	Bab-Taza	1	Talassemtane	1800	11.92	no
Rif	Bab-Berd	2	Tiziren	1800	11.92	no
Rif		3	Kétama (M.F. de Khandak Laanasseri)	1700	11.92	no
Rif		4	Tizi-Ifri (M.F.)	1800	11.92	no
Rif	Djbel Tazzeka	5	Tazzeka (relais télévision)	1900, 1950	11.92	no
Middle-Atlas	Ifrane	6	Azrou	1800	11.71	yes
Middle-Atlas	Ifrane	7	Ras-Al-Ma	1600	11.92	no
Middle-Atlas	Ifrane	8	Ich Ouharouk	1800	11.92	no
Middle-Atlas	Ifrane	9	Mtaljaste	1900	11.92	no
Middle-Atlas	Michlifen	10	Michlifen	2000	11.71	yes
Middle-Atlas		11	Col du Zad	2100	11.92	no
Great-Atlas	Tounfite	12	Tounfite	2100	11.92	yes
Great-Atlas		13	Sidi-Yahya-ou-Yousef	1750	11.92	no

¹ These numbers refer to the map (Fig. 1).² M.F. – forest house.TABLE 4. Stands of *C. libani* visited in Turkey.

Area	Sub area (Forester district)	No. ¹	Name of stand	Altitude (m)	Dates of investigations	Presence of <i>E. cedricida</i>
Pontic Chain	Amasya (Niksar)	1	Çatalan	800–1200	10.91	yes
Pontic Chain	Amasya (Niksar)	2	Akincilar	600–900	10.91	yes
Anatolia Mt.	Eskisehir (Afyon)	3	Sultandagi	1400	10.91	no
Anatolia Mt.	Isparta (Sarki Karaagac)	4	Kizildag Milliparki	1400	10.91	no
Anatolia Mt.	Isparta (Sarki Karaagac)	5	Belcegiz	1550	10.91	no
Anatolia	Mersin (Konya)	6	Saglik	1500	10.91	unconfirmed
Internal Eastern Taurus	Adana (Pozanti)	7	Cakit	1300	10.91	no
Internal Eastern Taurus	Adana (Pozanti)	8	Pozanti	1400–1600	10.90	no
Central Eastern Taurus	Kharamanmaras (Andirin)	9	Elmadagi	1300–1550	10.91	no
Central Eastern Taurus	Kharamanmaras (Andirin)	10	Kalekaya	950	10.91	no
External Eastern Taurus, Amanos	Antakya (Iskanderun)	11	Hassa	670–1500	10.91	no
Central Taurus	Mersin (Mersin)	12	Arslanköy	1800	10.90, 10.91	no
Central Taurus	Mersin (Mersin)	13	Cehennemdere	1050–2000	10.90	no
Central Taurus	Mersin (Anamur)	14	Abanoz Düden	1350–1500	10.90, 10.91	no
Western Taurus	Antalya (Elmali)	15	Ciglikara	1350–1860	10.91	no
Western Taurus	Antalya (Elmali)	16	Sevindik	1650	10.91	no
Western Taurus	Antalya (Finike)	17	Gülmez	450–1200	10.91	no
Western Taurus	Antalya (Kas)	18	Lengume	1200–1900	10.91	no
Western Taurus	Mugla (Fethiye)	19	Arpaçik	1400–	10.91	no
Western Taurus	Mugla (Denizli)	20	Konak	1300–1900	10.91	no

¹ These numbers refer to map (Fig. 1).

TABLE 5. Stands of *C. libani* visited in Lebanon².

Area	Sub area	No. ¹	Name of stand	Altitude (m)	Dates of investigation	Presence of <i>E. cedricida</i>
Mount Lebanon	Akkar	1	Kammouah	1350–1800	10.92	no
Mount Lebanon	Ehden	2	Ehden	1300–1900	10.92	no
Mount Lebanon	Hadeth	3	Bcharre	1950	10.92	no
Mount Lebanon	Hadeth	4	Arz El Hadeth	1200–1800	10.92	no
Mount Lebanon		5	Jaje	1400–1600	10.92	no
Mount Lebanon	Barouk	6	Barouk	1500–1700	10.92	no
Mount Lebanon	Barouk	7	Maasser-chouff	1400–1650	10.92	no

¹ These numbers refer to the map (Fig. 1).² Bariteau, 1992.TABLE 6. Results of the reciprocal crosses between adults of *E. cedricida* originating in Turkey and France, then between these hybrids and specimens originating in North Africa.

Cross	No. of couples	No. of females fertilized	No. of eggs laid	No. of caterpillars hatched
♂ "Turkey" × ♀ "France"	4	2	240	109
♂ "France" × ♀ "Turkey"	4	2	226	75
♂ "Turkey" × ♀ "Turkey" (control)	1	1	140	70
♂ hybrid × ♀ "Algeria"	1	1	72	72
♂ "Algeria" × ♀ hybrid	2	1	13	5
♂ "Morocco" × ♀ hybrid	1	1	69	43
♂ "France" × ♀ "France" (control)	54	16	941	928

Comparative morphology of the genitalia

Examination of the male genitalia revealed no morphological differences between specimens from the geographical areas (North Africa, Turkey, France) (J.P. Chambon, pers. comm.).

DISCUSSION

The discovery of *E. cedricida* in 1968 in the south of France on Atlas cedars introduced from Algeria last century suggested that this tortricid was of North-African origin. This hypothesis, presented by Leclant & Remaudière (1969), was furthermore in accordance with the then rudimentary knowledge of two other Atlas cedar pests which appeared to have followed this species when it was introduced into France. The first, the tortrymid *Megastigmus pinsapis* Hoffmeyer (Hymenoptera: Tortrymidae), discovered by Berland (1950) at Apt in the Vaucluse, had been reported in North Africa by Milleron (1949). The second, the aphid *Cedrobium laportei* Remaudière (Homoptera: Aphididae), described from specimens collected in Algeria in 1954, demonstrated its presence in France from 1967 onwards by causing considerable damage, which resulted in the death of park trees (Emmonot et al., 1967). The discovery of *E. cedricida* in Morocco and Algeria was in favour of the above hypothesis (Fabre, 1976; Leclant et al., 1977).

The hypothesis must now be reconsidered, since the presence of *E. cedricida* in several Turkish stands of *C. libani* no longer allows us to be sure of the North-African origin of the French populations, as they might equally originate from Turkey. At first, such a

hypothesis appears less likely in view of the greater proximity of North Africa. However it is known that another tortricid moth *Acleris undulana*, which originates from the natural range of *C. libani*, where it is present everywhere, was accidentally introduced into Morocco, in both Atlases, where it caused considerable damage (Fabre & Mouna, 1983).

A certain number of conclusions can be drawn from the discovery of *E. cedricida* in Turkey:

- The search for natural enemies of this tortricid, with a view to introducing them into Europe, must not be limited to North Africa, but should also include the stands of *C. libani*.

- *E. cedricida* is not specific to *C. atlantica*. Furthermore, the levels of its populations in Turkey were such that it does not permit great hope for a significant difference in natural resistance in both *C. libani* and *C. atlantica*.

- Of all the tortricids attacking cedars, *E. cedricida* is that with the greatest geographical distribution, both in the natural ranges of these conifers and their secondary range in Europe.

CONCLUSION

The discovery of *E. cedricida* in certain relictual cedar stands in Turkey represents an important step forward in our knowledge of this species. It challenges the hypothesis of a North African origin for the strain, accidentally introduced into France. It also leads to an appreciable adjustment in the context and strategy of the studies which have occurred for several years at the Mediterranean Forestry Research Unit of Avignon. The thought that the tortricid would be unable to colonize *C. libani* has disappeared and the search for its natural enemies in Turkey is essential. The absence of *E. cedricida* in the other Turkish cedar stands, in particular that of Mount Amanus, a relictual stand, in those of Lebanon and in the majority of the Moroccan stands is still to be confirmed, and there remains also the question of its possible presence in certain stands which have not yet been visited. These are located in Turkey (in the inner Eastern Taurus, for some authors the anti-Taurus, which is an inaccessible area), in Syria (in the Alaouites) and in Cyprus, (in the Trodos) this time on *C. brevifolia* (Bariteau & Ferrandes, 1992; Alptekin et al., 1997). The recent identification of the sex pheromone of the tortricid (unpublished data) will permit precise answers to these questions. In addition, it would be interesting to indicate the different geographical origin, firstly, by means of a comparative study of the development and the reproductive potential of the specimens and, secondly, by investigating and then utilizing molecular markers.

ACKNOWLEDGEMENTS. I should like to thank all those who have helped to make possible the investigations in the natural range of the genus *Cedrus* which have been visited: in Algeria, M. Khémici, G. Khous, M. Gachi, M. Zamoum, D. Mordji and S. Bahakémi; in Morocco, M. Mouna; and in Turkey, U.C. Alptekin. Thanks are due also to J.P. Chambon, who examined carefully numerous adult specimens from different geographical areas, and our technician A. Chalon, who performed many of the investigations in France and supervised the rearing of the tortricid in quarantine.

REFERENCES

ALPTEKIN C.U., BARITEAU M. & FABRE J.P. 1997: Le Cèdre de Turquie: aire naturelle; insectes ravageurs; perspectives d'utilisation en France. *Rev. For. Fr.* (in press).

- AKSOY H. & ÖZALP G. 1990: Forest communities of Cedar in Turkey. In: *International Cedar Symposium, 22–27 October 1990, Antalya, Turquie. Miscellaneous publ. 59.* Ormancilik Arastirma Enstitüsü (Forest Research Institute), Antalya, pp. 93–102.
- ANSIN R. & KÜÇÜK M. 1990: Floristic investigations on the natural cedar stands in Niksar and Erbaa. In: *International Cedar Symposium, 22–27 October 1990, Antalya, Turquie. Miscellaneous publ. 59.* Ormancilik Arastirma Enstitüsü (Forest Research Institute), Antalya, pp. 1–12.
- BARITEAU M. 1992: Assistance au reboisement, République du Liban. *Rapport d'Expertise FAO, Programme TCP/LEB/2251(T)*. FAO, Rome, 28 pp.
- BARITEAU M. & FERRANDES P. 1992: Les cèdres. In Gallais A. & Bannerot H. (eds): *L'Amélioration des Plantes*. INRA, Paris, pp. 732–743.
- BERLAND L. 1950: Un chalcidien phytophage, *Megastigmus suspectus* var. *pinsapinis*. *Entomologiste* **6**: 56–57.
- BEUG H.J. 1967: Contributions to the postglacial vegetational history of the northern Turkey. *Quaternary Palaeoecology* **7**.
- CAVALCASELLE B. 1985: Consultation en Entomologie Forestière, Algérie. *Rapport de consultation FAO, projet ALG/83/013*. FAO, Rome, 30 pp.
- CHAMBON J.P., FABRE J.P. & KHEMICI M. 1990: Trois nouvelles tordeuses d'Algérie, nuisibles aux conifères: *Epinotia algeriensis* sp. n. (Olethreutinae, Ecosmini), *Lozotaenia cedrivora* sp. n. and *Dicheilia numidicola* sp. n. (Tortricinae, Archipini) [Lepidoptera, Tortricidae]. *Bull. Soc. Entomol. Fr.* **95** (3–4): 131–138.
- DIKONOFF A. 1969: A new tortricid injurious to cedar in France (Lepidoptera). *Ann. Soc. Entomol. Fr.* **5**: 389–396.
- EMMONOT P., GAYRAUD Y., LECLANT F. & REMAUDIÈRE G. 1967: Sur la présence en France de *Cedrobium laportei* Remaudière, puceron nuisible au cèdre. *C. R. Acad. Agr. Fr.* **53**: 966–971.
- FABRE J.P. 1976: Extension du cèdre et risques d'attaques d'insectes. *Rev. For. Fr.* **4**: 261–269.
- FABRE J.P. & MOUNA M. 1983: Sur la présence au Maroc d'une tordeuse, *Acleris undulana* Walsingham (Lepidoptera: Tortricidae), grave ravageur des cèdres: *Cedrus atlantica* Manetti, *Cedrus libani* Barrel. *C. R. Acad. Agr. Fr.* **69**: 642–647.
- HUEMER P. 1994: Schmetterlinge (Lepidoptera) im Naturschutzgebiet Rheindelta (Vorarlberg, Österreich): Artenbestand, Ökologie, Gefährdung. *Linzer Biol. Beitr.* **26**: 3–132.
- HUEMER P. & TARMANN G. 1993: *Die Schmetterlinge Österreichs (Lepidoptera)*. Tiroler Landesmuseum Ferdinandeum, Innsbruck, 224 pp.
- LECLANT F. & REMAUDIÈRE J. 1969: Sur la biologie d'*Epinotia cedricida* Diak., grave ravageur du cèdre en France (Lep.: Tortricidae). *Ann. Soc. Entomol. Fr.* **5**: 397–405.
- LECLANT F., EL IDRISSI A. & MIERMONT Y. 1977: Les aphides et les tortricides du cèdre au Maroc et en France et leurs parasites. *C. R. Acad. Sci.* **284**: 647–649.
- MAYER H. & AKSOY H. 1986: *Wälder der Türkei*. G. Fischer, Stuttgart, 290 pp.
- MILLERON H.E. 1949: Taxonomic and biological investigations in the genus *Megastigmus* with particular reference to the taxonomy of the Nearctic species (Hymenoptera, Chalcidoidea, Callimomidae). *Am. Midland Nat.* **41**: 257–240.
- SELÇUK M. 1962: Erbaa-Çatalan sedir Ormani reji rejiyonal kesiti ve yeni bir sedir ormanimiz. (The forest of Erbaa-Çatala, a new place where is natural forest of cedar.) *Orman Mühendisligi Dergisi* **4**: 3–7.

Received June 10, 1996; accepted October 2, 1996