

# The Polyommatine wing pattern elements and seasonal polyphenism of the Indian *Chilades pandava* butterfly (Lepidoptera: Lycaenidae)

Krushnamegh Kunte<sup>1</sup> and Ashish Tiple<sup>2</sup>

FAS Center for Systems Biology, Harvard University, Cambridge, MA 02138, USA<sup>1</sup> [KKunte@cgr.harvard.edu](mailto:KKunte@cgr.harvard.edu)

Department of Zoology (Entomology Division) and Centre for Sericulture and Biological Pest Management Research (CSBR), RTM Nagpur University Campus, Nagpur 440033, India.<sup>2</sup> [ashishdtiple@yahoo.co.in](mailto:ashishdtiple@yahoo.co.in)

Many butterfly species show environmentally induced but genetically determined discrete seasonal forms. This is known as seasonal polyphenism. The seasonal forms may have contrasting life history strategies in response to varying seasonal and social conditions such as ambient temperature and day-length, differential availability of secure resting places, nectar plants for adults and larval host plants, and a different set of predators and predation risk (reviews in Brakefield and Larsen 1984; Brakefield *et al.* 2007; Nijhout 2003, 1991; Shapiro 1976). Although extensively investigated only in some Holarctic and African pierid and nymphalid butterflies such as *Colias*, *Araschnia* and *Bicyclus*, seasonal polyphenism occurs extensively outside these groups within Pieridae, Nymphalidae and in some Hesperidae (Brakefield and Larsen 1984). The nature and diversity of seasonal polyphenism in these groups, however, are poorly known.

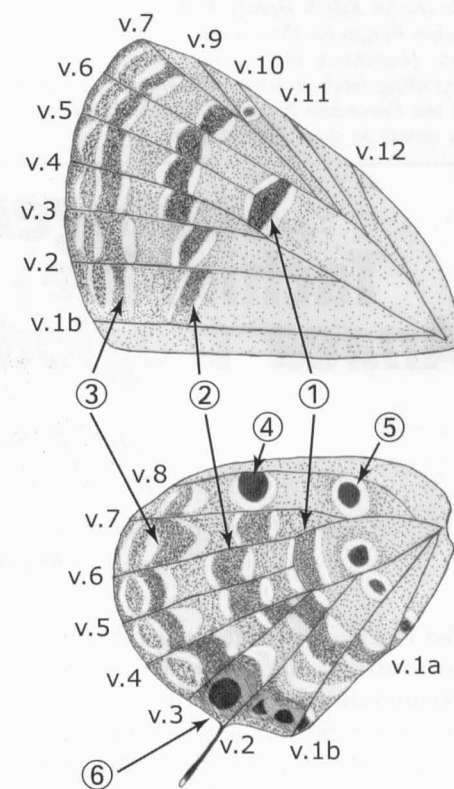
Here we describe in detail seasonal polyphenism of *Chilades pandava* Horsfield, 1829 (Lycaenidae: Lycaeninae: Polyommadini). First we will describe in detail the wing pattern elements of *C. pandava*, which follow the general Polyommatine pattern. Then we will show how individually variable change in coloration of spaces between specific wing pattern elements produces the remarkable diversity of dry season forms in this species.

## Wing pattern elements of *Chilades pandava*, and changes between the seasonal forms:

The Polyommatine wing pattern elements are clearly homologous to the nymphalid ground-plan (Nijhout 1991). These are illustrated in Fig. 1 and Fig. 2.3 by the wet season form of *C. pandava*, and are as follows: (1) Both wings have a dark brown bar at the terminal end of the cell. (2) Both wings have a dark brown discal band between veins 1b and 7 (the distal band of the central symmetry system, Nijhout 1991). This band is composed of spots that are bounded by wing veins. The positions of these spots differ in each wing area, as also seen in nymphalids (Nijhout 2001). (3) Both wings have a sub-marginal dark brown band. (4) The hind wing has a large, black costal spot in wing space 7 (between veins 7 and 8). (5) The hind wing also has a series of sub-basal black or dark brown spots: one in wing space 7, one in the cell, one in wing space 1c closely juxtaposed with the spot in the cell, and one in space 1a along the dorsal wing margin. The first three wing pattern elements are bounded on both sides by narrow white bands, and the last two elements are ringed white. The inner white margins of the sub-marginal band on the hind wing are crescent-shaped and much broader than the rest. (6) Among the series of marginal spots, the tornal spot in wing space 2 (just above the tail) is large, black and broadly crowned orange. The tornal spots in 1c are much smaller and narrowly crowned orange. The ground color of the wings is usually very light brown but may be light grey or grey-brown in some specimens. However, the arrangement and presence of these

wing pattern elements in the wet season form are nearly invariable, as evidenced by only slight individual variation among the several hundred specimens that we have inspected in the field and in research collections.

The dry season form, on the other hand, is remarkably variable. Individuals only



**Fig. 1:** Wing pattern elements of *C. pandava*. The veins are numbered. The wing pattern elements, demarcated by veins, are organized into several series of spots, some of which form bands: 1: cell-end bar; 2: discal band; 3: sub-marginal band; 4: costal spot in the wing space 7; 5: sub-basal spot in space 7, followed by three sub-basal spots in the cell and spaces 1c and 1a; 6: tornal orange-crowned black spots. Illustration: Krushnamegh Kunte.





**Fig. 2:** Diversity and individual variation in the seasonal forms of *C. pandava*. Note how individual variation in the extent and coloration of the wing pattern elements produces the remarkable diversity of the dry season forms in this species. **1 & 2:** upper sides of male, **4:** upper side of female. **1, 3 & 4:** wet season form of *C. pandava*. **2 & 5-12:** dry season forms of *C. pandava*. **13 & 14:** wet and dry season forms of *C. lajus*. **15 & 16:** normal and aberrant forms of *Azanus jesous*. The specimen details are as follows: **1:** Indira Gandhi National Park (IGNP), the Anamalais, Tamil Nadu, 28.v.2004. **2 & 8:** Indian Botanic Garden, Shibpur, West Bengal, 4.xi.07. **3:** Palamau Wildlife Sanctuary (WLS), Jharkhand, 17.vii.2004. **4:** Dandeli WLS, Karnataka, 2.xi.08. **5-7, 9-11:** Ambazari Garden, Nagpur, Maharashtra, **5:** 16.iii.2008, **6:** 23.ii.2008, **7:** 25.x.2007, **9:** 4.xi.2007, **10:** 30.x.2007, **11:** 30.x.07. **12:** Simlipal Tiger Reserve, Orissa, 7.i.2008. **13:** IGNP, Tamil Nadu, 3.vi.2004. **14:** Pune, Maharashtra, 26.xi.2006. **15:** Kumbalgadh WLS, Rajasthan, 4.vii.2004. **16:** Chinnar WLS, Kerala, 6.ii.08. (Photo credits: Rudraprasad Das [2, 8], Aniruddha Dhamorikar [4], Shreepad Hardas [14], Rafeek Khalid [16], Krushnamegh Kunte [1, 3, 13, 15], Manoj Nair [12], Ashish Tiple [5-7, 9-11]).



slightly affected by the climatic conditions that produce the dry season form show all the characteristic wing pattern elements of the wet season form except that (1) the costal spot and the sub-basal spot in 7 on their hind wing turn brownish, and (2) the discal bands become lighter, sometimes almost as light as the ground color (Fig. 2.5-6). The typical dry season form, however, differs from the wet season form as follows: (1) The dark brown spots of the discal band in spaces 4 and 5 on the hind wing extend inwards and coalesce with the cell-end bar, forming a large brown area (Fig. 2.7-10). (2) The outer white margin of the discal band and inner white margin of the sub-marginal band coalesce either on both the wings (Fig. 2.10) or only on the hind-wing (Fig. 2.7-9 and 2.11), forming a broad white discal or post-discal band (Evans 1932; Pinratana 1981).

### Individual variation and stability of the seasonal forms:

The following changes in coloration show considerable individual variation, which produce additional notable patterns among the dry season forms of *C. pandava*: (1) discal spots and cell-end bar may either coalesce on the fore wing (Fig. 2.10) or the discal spots increase in width (Fig. 2.7 and 2.12). (2) The white inner margin of the fore wing sub-marginal band becomes diffused to a variable extent (Fig. 2.5-11). (3) The area between the discal spots 4 and 5 and the cell-end bar on the hind wing becomes sooty-brown or black (Fig. 2.9-10). (4) The tornal orange-crowned black spots on the hind wing are either absent, greatly reduced in size, or without the orange (Fig. 2.5-12). (5) In highly unusual dry season forms, the discal and sub-marginal elements appear smeared (Fig. 2.12). (6) If the discal and sub-basal spots are elongated, their outer margins may turn black (Fig. 2.9-10).

The sexes are similar on the underside, although on the upper side males are brighter blue with narrow black borders whereas females have much broader borders (Fig. 2.1 and 2.4). However,

there are small seasonal differences in the coloration and wing patterns on the upper side in both the sexes. In some males the blue coloration may be duller and the black border may be broader towards the apex (Fig. 2.2), but we do not know how commonly this occurs.

The seasonal polyphenism in *C. pandava* is not an isolated occurrence among Indian Polyommata or Lycaeninae is general. In *Chilades lajus* Stoll, 1780, the dry season form has an extensive smear of dark brown on the hind wing from the cell-end bar to the wing margin, which is lacking in the wet season form (Fig. 2.13-14). In the dry season form of *Jamides celeo* Cramer, 1775, the spaces between the discal bands on both the wings are filled with dark brown whereas the tornal orange-crowned black spot is highly reduced in size and orange coloration (Kunte 2000). In *Azanus jesus* Guérin-Méneville, 1849, we have not observed a dry season form in southern India but an aberrant specimen photographed during the dry season showed several discal and sub-marginal wing pattern elements coalesced to form brown blotches (Fig. 2.15-16). Torben Larsen (personal communication) has seen neither seasonal forms nor aberrantly marked individuals among thousands of *A. jesus* in Africa. However, the aberrantly patterned specimen depicted in Fig. 2.16 shows that there is developmental and/or genetic potential for seasonally polyphenic coloration in *A. jesus*. It also shows that similar type of color smearing between the wing pattern elements occurs in *A. jesus* and in *C. pandava*, which appears to be a common response to high summer temperatures in *Chilades* and other Polyommata and Lycaenine butterflies.

The Indian butterfly fauna offers several nymphalid examples of seasonal polyphenism: *Melanitis leda*, *Mycalis* spp., *Junonia almana*, as well as their close relatives (Brakefield and Larsen 1984; Nijhout 1991). Many pierids are also known to be seasonally polyphenic, *Eurema laeta* Boisduval, 1836, being a remarkable example in which both

wing coloration and shape change between the seasons (Brakefield and Larsen 1984; Kunte 2000). The wet season form in *E. laeta* is bright yellow with rounded wings, and the dry season form is very dull yellow with pointed wings, which helps the butterflies blend with leaf litter during the dry season and escape predation. This note highlights a little-known but promising and phylogenetically distant example for further studies on seasonal polyphenism. Population dynamics and seasonal polyphenism in *C. pandava* have already been reported (Tiple et al. 2009). However, other aspects of seasonal polyphenism may also shed light on its ecology and evolution in *C. pandava*. For example, there is geographic variation in the occurrence of seasonal forms in *C. pandava*. The dry season forms have not been reported in the Sri Lankan subspecies, *C. p. lanka* Evans, 1925, and in populations of *C. p. pandava* in the humid tropical areas in south-east Asia (Evans 1932). These population and subspecific differences may merely indicate the lack of climatic factors (high temperatures and lower rainfall and relative humidity) that induce the dry season forms in *C. pandava* (Tiple et al. 2009). However, the possibility of polyphenism-related genetic differences and genetic assimilation cannot be overruled. Detailed comparative studies of the central Indian populations of *C. pandava* with other subspecies and closely related, seasonally non-polyphenic species may inform on the evolution of seasonal polyphenism in the tribe Polyommata.

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*Continued on pp. 109*

# Membership Update...

Julian Donahue

Includes all changes received by 23 October, 2009

## Additions/corrections to entries in 2008 Membership Directory:

Hall, Jason P.W. (Dr.): add mail code "MRC-105"

## New and Reinstated Members:

members who have joined/renewed/ been found/or rescinded their request to be omitted since publication of the 2008 Membership Directory (not included in the 2008 Membership Directory; all in U.S.A. unless noted otherwise)

**Arthur, Noah:** 3648 Nevil Street, Oakland, CA 94601-3818.

**Burks, Charles (Ph.D.):** 750 East Ponderosa Avenue, Reedley, CA 93654-2236.

**Hoyt, Cathryn A. (Ph.D.):** P.O. Box 215, Fort Davis, TX 79734-0003.

**Jantscher, Thomas:** 3850 Glacier Place, Plymouth, MN 55446-3334.

**Kertell, Ken:** 4344 East Monte Vista Drive, Tucson, AZ 85712-1631.

**Selby, Joseph:** [address omitted by request]

**South, Nigel:** Mis Montana's, Los Robles 1818, Villa Los Altos, Rio Ceballos, Cordoba 5111, Argentina.

**Wilcox, Mark W.:** 2770 North 1775 East, Layton, UT 84040-8591.

**Yukich, Bob:** 39 Lincoln Avenue, Toronto, Ontario M6P 1M7, Canada.

## Address Changes

(all U.S.A. unless noted otherwise)

**Caldas, Astrid (Dr.):** 5401 Christy Drive, Bethesda, MD 20816-2013.

**Daniels, Emily Vanessa:** 1013 Verano Place, Irvine, CA 92617-3188.

**de Mordaigle, Rodolphe C.:** P.O. Box 184, Olancho, CA 93549-0184.

**Hardaway, John F.:** 121 Aspen Trail, Columbia, SC 29206-4978.

**Johnson, Kurt (Dr.):** 135 Eastern Parkway, Apt. 7G, Brooklyn, NY 11238-6024.

**Lohman, David (Ph.D.):** Department of Biology, The City College of New York, 160 Convent Avenue, New York, NY 10031-9101.

**Miller, Stephen S.:** P.O. Box 297, Penn Valley, CA 95946-0297.

**Ross, Dana N.:** 1005 NW 30th Street, Corvallis, OR 97330-4441.

**Rumpsa, Paul:** 14358 Waco Street NW, Ramsey, MN 55303-6176.

**Simonsen, Thomas J. (Ph.D.):** Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, England.

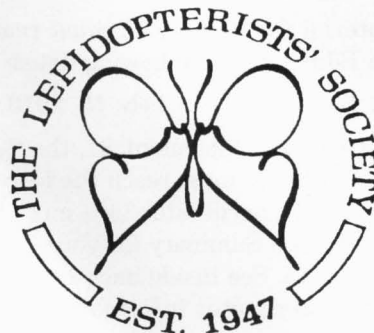
**Weinberger, Marc:** 1823 Mariposa Drive, Petaluma, CA 94954-5794.



## Northern Population of *Isturga dislocaria*

*Continued from pp. 104*

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- Marie-Victorin. 1995. Flore Laurentienne, 3e Édition. Les Presses de l'Université de Montréal, Montréal, 1093 pages, 120 planches.
- Handfield, L. 1999. Le guide des Papillons du Québec, version scientifique. Broquet, Boucherville, 982 pages, 125 planches, 1 planche frontale et 1 carte.



## Seasonal polyphenism of *Chilades pandava*

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## Lepidoptera Paintings of Pamela Lewis

*Continued from pp. 105*

the painting was done for C. Hunter Sheldon, M.D., and its title actually honors *him*.

When I saw the book I knew I *had* to tell my fellow Lepidopterists about it, so I contacted her family, who very graciously agreed to this article. A few representative paintings are shown here (see back cover, pp 112). You can view the entire set at <http://www.fruitfly.org/lewis/Site/Back.html>. Limited-edition prints of some of the paintings may be available. For information contact <[pam.lewis.book@comcast.net](mailto:pam.lewis.book@comcast.net)>.

