

Contents

animal

Preface: *Homo sapiens, the rational animal*

vii

Chapter 1 Evolution, genetics, and systematics

1

1.1 The theory of evolution

1

1.2 Population and evolutionary genetics

9

1.3 The classification of living beings

33

Chapter 2 The evolution of hominoids

44

2.1 Hominoid taxonomy

44

2.2 Early Miocene hominoids

54

2.3 Middle Miocene: the migration of apes out of Africa

61

2.4 Late Miocene: the divergence of great apes

70

Chapter 3 The hominin lineage

81

3.1 The origin of hominins

81

3.2 Bipedal locomotion

92

Chapter 4 Miocene and Pliocene genera and species

106

4.1 The first hominins

106

4.2 *Australopithecus*

117

Chapter 5 Pliocene hominins: South Africa and the Rift Valley

135

5.1 South African sites

135

5.2 South African hominins of the Pliocene

145

5.3 The "gracile" and "robust" alternatives in East Africa

156

Chapter 6 The Pliocene cladogenesis: *Paranthropus* versus *Homo*

166

6.1 Evidence from Koobi Fora

166

6.2 Alternatives in the evolution of robust and gracile clades

181

Chapter 7 The radiation of *Homo*

194

7.1 Asian *Homo erectus*

194

7.2 The *erectus* grade in Africa

205

Chapter 8 Evolutionary characteristics of the *erectus* grade

216

8.1 Cultural patterns in the migration out of Africa

216

8.2 The earliest cultures

228

8.3 *Homo* in Europe

241

Camilo J. Cela-Conde
Francisco J. Ayala

Chapter 9 The late-Pleistocene transition	253
9.1 Archaic <i>Homo sapiens</i>	253
9.2 Neanderthals	271
9.3 Molecular data	287
9.4 The origin of modern humans	300
Chapter 10 The uniqueness of being human	314
10.1 Culture and mental traits during the late Paleolithic	314
10.2 The origins of symbolism	326
10.3 The origin of language	339
10.4 The evolution of moral behavior	353

Glossary	367
References	377
Index	419

Argentia Austria Brazil Chile Czech Republic France Greece
Guatemala Hungary Italy Japan South Korea Portugal
Singapore Switzerland Thailand Turkey United Kingdom
With offices in:
Oxford is a registered trademark of Oxford University Press in the US and in certain other countries

Published in the United States
by Oxford University Press Inc., New York
© Oxford University Press 2010
Reprinted 2010

The moral rights of the author have been asserted.
Database right Oxford University Press 2010
Reprinted 2010

All rights reserved. No part of this publication may be reproduced,
stored in a retrieval system or transmitted in any form or by any means,
without the prior permission in writing of Oxford University Press 2010,
or as expressly permitted by law. For further information about
reprographics rights, please apply to Oxford University Press at the address
outside the scope of the above terms of use or in the usual way.

Oxford University Press, at the address above,
You must not circulate this work in any form or by any means,
And you must impose this same condition on any subsequent user.

ISBN 978-0-19-800558-7

Printed in the United Kingdom by
Lightning Source UK Ltd, Wokingham, Surrey

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the author

Changes not to be made without permission of the