Oak Ambrosia Beetle, *Platypus quercivorus* (Murayama), Phenology (Degree-Day) Model
Analysis by Len Coop, Integrated Plant Protection Center, Oregon State University, July 22, 2016

Summary of model version 1.0:

Common Name: Oak Ambrosia Beetle		
Scientific Name: *Platypus quercivorus (Murayama)*		
Start Date: Jan 1	**Temp (C)**	**Temp (F)**
Tlow:	11.1	52
Thi:	38.0	100.4
	DD (C)	**DD (F)**
Estimate of egg devel period:	125	224
Estimate of larval devel period:	805	1449
Estimate of pupal devel period:	218	392
Estimate of teneral adult period:	111	200
Est egg+larv+pup+ten adult:	1486	2675
Est. summer gen time (1st emerg-1st emerg)	1214	2185
Est. summer gen time (50% emerg-50% emerg)	1491	2684
Est. pupation:	235	423
Est. first emerge:	453	815
Est. 50% emerge:	683	1229
Est. end emerge:	1167	2101
Est. peak larvae develop in galleries:	1355	2440
Est. 2nd Gen 1st emerge	1709	3076
Est. 2nd Gen 50% emerge	2139	3850
Est. 2nd Gen end emerge	2492	4486

Source for images: **http://www.rinya.maff.go.jp/tohoku/syo/asahi/siryou/kasinaga.html**


Eggs


Larvae


Damaged wood


Adult Males

Sources:

1. APHIS PPQ pest datasheet Exotic Wood Borer/Bark Beetle Survey Reference 2013.

-usually 1 gen. per year
-eggs hatch 1 week after oviposition
-larvae feed on the fungus
-30 to 40% of broods reach adulthood between Aug and Oct **(**Sone et al 1998**)**
-remainder OW in the 5th instar and emerge mid-June **(**Sone et al 1998**)**
-CAPS surveys should put up traps in May when adults are mating **(**Davis etal 2005**)**

2. Sone, K, T. Mori, and M. Ide. 1998. Life history of the oak borer, Platypus quercivorus (Murayama). Appl. Entomol. Zool. 33:67-75.

-Study site in Takakuma Exper. Forest of Tarumizu city, Kagoshima Prefecture **(**need 1994-6 weather data**)**
-in Japan, greatest infestation occurs from June to early July
-most attacks within 3 weeks of first attack
-larvae usually found July and onward through OW **(**in 5th stage**)**
-pupation usually starts in May
-by Sept, 64%, by Oct, 76% and by Nov, 90% in 5th instar
-2nd gen emerg. Sept-Oct for a portion of the population
-1995 adult females emerged 8th of June, peaked mid-June, through 18 July
-1995 2nd gen. adults began to fly by end of Aug, peak in mid-Sept and early Oct, ceased in early Nov.
-1996 adults caught from 3 June to 30 July; peak in late June and early July

-prefer dibilitated trees and fresh logs to vigorous living trees
-about 30-40% reached adult stage from aug-oct, thus able to start a 2nd generation
-late fall adults may not start new broods but may help in cleaning existing galleries
-some may take 2 years to complete life cycle
-higher reproductive success in logs (40-50 per female) vs live trees **(**5-10 per female**)**
-sap production is most likely the limiting factor to success in live trees
-1995 new gallery started Oct 6-18 did not develop (only 2-3 weeks of warm weather remained in season)

Adult Emerg Data (Fig 6): (DD data Kagoshima near sea level; do not use:)

	1994		1995		1996	
Medium	live trees		prepared logs		prepared logs	
notes			text and fig d	Cum. DDs C		Cum. DDs C
approx pupati	05/01/94	307	05/08/95	303	05/11/96	304.0
First attack	06/04/94	650	06/15/95	696		
50% attack	06/16/94	800	06/26/95	831		
end attack	07/25/94	1461	08/15/95	1680		
2nd Gen attack	NA		10/12/95		NA	
First emerge			06/06/95	594	06/05/96	568.0
50% emerge		1423	06/20/95	761	06/30/96	925.0
end emerge			07/18/95	1182	07/25/96	1341.0
peak egglayin	07/10/94	1175	07/20/95	1218		
mostly 5th stag	09/01/94	2136	09/15/95	2226		
2nd Gen 1st emerge			08/26/95	1888	NA	
2nd Gen 50% emerge			09/25/95	2349	NA	
2nd Gen end emerge			11/02/95	2739	NA	

Use Modified Weather Data: (elevation adjustment: Tmax-1.5, Tmin-0.5), also data from Kyoto 2007 & 2010 (Sources 5&6 below)

Adult Emerg Data (Fig 6):

	1994 (Kagoshima)		1995 (Kagoshima)		1996 (Kagoshima)		2007 (Kyoto)		2010 (Kyoto)		
Medium:	live trees		prepared logs		prepared logs						Average
		Cum. DDs C	text and fig d	Cum. DDs C		Cum. DDs C	Date	Cum. DDs C	Date	Cum. DDs C	Cum. DDs C
approx pupati	05/01/94	238	05/08/95	233	05/11/96	234					235
First attack	06/04/94	547	06/15/95	588					06/18/10	555	563
50% attack	06/16/94	686	06/26/95	713							700
end attack	07/25/94	1308	08/05/95	1345							1327
2nd Gen attack	NA		10/12/95		NA						
First emerge	06/04/94	547	06/06/95	495	06/05/96	473	05/20/07	295			453
50% emerge			06/20/95	648	06/30/96	806	06/18/07	594			683
end emerge			07/18/95	1041	07/25/96	1197	08/03/07	1264			1167
peak egglayin	07/10/94	1037	07/20/95	1075							1056
mostly 5th stag	09/01/94	1945	09/15/95	2026							1986
2nd Gen 1st emerge			08/26/95	1709	NA						1709
2nd Gen 50% emerge			09/25/95	2139	NA						2139
2nd Gen end emerge			11/02/95	2492	NA						2492

Summary of stage interval DDs: (all in Celsius)						
	1994 (Kagoshima)	**1995 (Kagoshima)**	**1996 (Kagoshima)**	**2007 (Kyoto)**	**2010 (Kyoto)**	**Average**
Estimate of Jan 1-pupation:	238	233	234			235
Est. of pupal+teneral (pre-attack)	309	355				332
Est. egg+larval devel	908	951				930
Estimate of egg devel period:	129	120				125
Estimate of larval devel period:	779	831				805
Estimate of pupal devel period:		262				218
Estimate of teneral adult period:		93				111
Est. teneral adult+tunnel building+initial egglaying (0.35)						339
Est full generation: egg+larv+pup+ten adult+tunnel building+initial egglaying:						1486
Est. summer gen time (1st emerg-1st emerg)		1214				1214
Est. summer gen time (50% emerg-50% emerg)		1491				1491
Est. summer gen time (end emerg-end emerg)		1451				1451
Summary of events after Jan 1st:						
Est. spring pupation:	238	233	234			235
Est. first emerge:	547	495	473	295		453
Est. 50% emerge:		648	806	594		683
Est. end emerge:		1041	1197	1264		1167
Est. first attack:	547	588			555	563
Est. 50% attack:	686	713				700
Est. peak larvae develop in galleries:						1355
Est end attack:	1308	1345				1327
Est. 2nd Gen 1st emerge		1709				1709
Est. 2nd Gen 50% emerge		2139				2139
Est. 2nd Gen end emerge		2492				2492

	(KAGOSHIMA94.txt)		(KAGOSHIMA96.txt)			
Kagoshima DDs 1994-96				Modified to reflect higher elevation forest		
Month	Cum. DDs 94	Cum. DDs 95	Cum. DDs 96	1994	1995	1996
Jan	28	18.9	19.4	17	12	11
Feb	49	41.1	42.8	28	24	26
Mar	107	109	112	68	72	76
Apr	307	259	229	239	196	169
May	616	542	517	518	448	427
Jun	1011	888	938	882	764	818
Jul	1586	1427	1477	1425	1272	1326
Aug	2137	1994	2028	1946	1809	1845
Sept	2562	2420	2488	2340	2204	2275
Oct	2871	2736	2801	2618	2489	2557
Nov	3058	2829	2967	2778	2560	2698
Dec	3119	2848	3013	2822	2569	2731
	warm	cool	moderate			

3. Sone Uto Fukuyama and Nagano 2000

-galleries started June and July resulted in new adults emerging in Sept and Oct 1997

4. APHIS Mini Risk Assessment. Davis, E, S. French, and RC Venette. 2005.

-common in parts of Japan and is present in India, Taiwan, Indonesia, and Papua New Guinea; the pathogen only reported from Japan
-occurs in temperate or tropical climates w/adequate seasonal rainfall to support deciduous tree hosts.
-new adults emerge and disperse beginning in late June through early Oct or Nov **(**Sone etal 1998, Kinuura 2002**)**
-eggs laid about 2-3 weeks after gallery construction is initiated; egg hatch occurs in about one week
-larvae OW in (or not in) diapause in the larval gallery
-pupae occurs in May followed by emergence of adults in June and July
-may OW as pupa or adult; adults less likely to survive

5. Yamasaki, M. H. Iizuka, and K. Futai. 2012. Reproductive success of the ambrosia beetle Platypus quercivorus on Quercus laurifolia planted in. Japan

For. Res. Kyoto 78:29-38.
-emerg. from Q. laurifolia similar to Q. crispula

Fig. 4a. Male and female emergence from Q. laurifolia
Females emerg:

Date	% Emerg	Dds (KYOTO07.txt)
05/20/07	3.00%	295
06/18/07	50.00%	594
08/03/07	97.00%	1264

6. Tarno, H. H. Qi, M. Kobayashi, and K. Futai. 2012. Two active stages of ambrosia beetle, Platypus quercivorus M. estimated from frass production. Agrivita 34:207-214.

-after attack there is a fibrous frass stage (adult feeding), an intermediate stage, and a powdery frass stage (larval feeding)
-fibrous frass stage between 5 and 21 days in lab (lab was 26C); mean duration 11.14 days +/- 4.83
-intermediate stage between 2 to 20 DAYS in lab; mean 11.95 days +/- 4.87
-start of 3rd stage ranged from 19th to 27th days in lab; continued until day 40 (end of study?)
-in Kyoto 2010, attack began mid-June (ca. 515 DD)

est. Dds fibrous stage = 26-11.11*11.14	166	(tunnel building)
est. DDS intermed stage	178	(egglaying+egg devel+1st&2nd instars)
est. DDS powdery stage (likely is longer due to study	194	(3-5 instar feeding)

using Tlow=11.1 Tupper=38, mid-June in Kyoto
Kyoto DD summary (KYOTO10.txt)

Month	2010 Dds	2007 Dds			
Jan	2.8	1.7			
Feb	23.3	17.2			
Mar	48.3	57.8			
Apr	127.2	161			
May	355	407			
Jun	745	777	06/18/10	555	(est first attack Kyoto 2010)
Jul	1273	1228			
Aug	1878	1800			
Sept	2322	2258			
Oct	2629	2496			
Nov	2691	2567			
Dec	2708	2576			

7. Basis for lower and upper developmental temperatures:

1. Gaylord, ML, KK Williams, RW Hofstetter, JD McMillin, TE Degomez, and MR Wagner. 2008. Influence of temperature on spring flight initiation for southwestern Ponderosa pine bark beetles. Eniviron. Entomol. 37:57-69

-used Tlow = 11C for Ips pini in comparison to 7 other bark beetles based on Miller and Keen 1960 and Ungerer et al 1999 (D. frontalis)

Attack in Kyoto starts June = high Tlow (such as 11C); note that even by mid-May Tmax regularly exceeds an adult flight temp threshold (15C)

C	F	
11	51.8	
11.11	52	← use this as Tlow
10.56	51	
38	100.4	← use for Tupper

-phloem temps differ from ambient temps by 1 to 2 deg. C.

-study emphasized flight temps which ranged for 7 species at: 16C (I. pini), 18.6C (D. brevicomis); 16.1 (D. frontalis)

- (cont.), lowest flight temps for I. pini was 16.1 C; but beetles were captured when flight temps were as low as 11.7 C

-conclude/suggest that once a threshold flight temp reached in the spring, flight occurs at lower temps during subsequent months

-same study upper flight temps where Tmax was ca. 38.9, 37.9 (37-38C)

-only 1 spp. had lower temp thresholds (D adjunctus) where you could argue for an upper flight temp threshold **(**Tmax < 27 C**)**

-for most species, flight initiated when spring Tmax began to exceed 15C; so this might be a good Tlow for Adult stage (if needed)

-similarly in the Fall, monitoring should continue until Tmax regularly fails to reach 15C for 4 species (13 and 10C for other spp.)